GAS JOURNAL, DEC. 18, 1946

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DISTRICT HEATING

AT the Conference of the Ministry of Fuel and Power, recently held, district heating was dealt with in seven papers. One of the speakers visualized a town of 250,000 inhabitants who would be served for hot water and space heating exclusively and uniformly by this method. He calculated that on the basis of 1937 prices the cost per therm delivered to the consumer would be 4.62d., which on his basis of 575 therms per annum is equivalent to £11 1s. 4d. or about 4s. 3d per week. District heating, however, is defined as "the supply of heat for space heating and hot water in the form of a public service." It is to be presumed, though the Author is not explicit on this point, that gas or electricity would be required in addition for cooking, for "topping-up" and perhaps for home laundry. Nothing is provided for ventilation. This is not very formidable competition particularly when it is borne in mind that every consumer in this Utopian township would be taking his full supply—that is, one hundred per cent. saturation.

Professor Holford considered district heating in relation to town and country planning and he rightly enlarged on the reduction of fog and smoke that would follow its adoption. In common with other forms of smokeless, dustless heat (or fuel) supply it would eliminate "the effects of black smoke and sulphur dioxide," and relieve its inhabitants of "the toll of disease, discouragement and death which is all the time being paid in the background." Professor Holford recognizes that flues would be required for ventilation and for apparatus used for "topping-up." From his point of view district heating would eliminate the need for a considerable number of lay-bys, loading docks, chutes, hoppers and fuel bins, boiler houses, chimneys, stokers and cleaners. It would rid the narrow streets of coal carts and fuel lorries. It would relieve the housewife of the dust and grit, the time-consuming drudgery and the irritation entailed in the use of the open fire. And it provides, in addition to all the other utilities required in the model town, the additional service of district heating and clean air.

Professor Holford recognizes something which most of the other writers miss. He recognizes that this new service will impose a constant addition to rents and rates. "Where a poor householder could make desperate economy by denying himself a coal fire altogether, he will not be able, in any particular week or month, to turn off the district heating." He appreciates also the difficulty of the adoption of the new system in existing towns where the new mains—and remember these are large insulated mains—would have to be accommodated below the street surface where several other sets of mains and conduits already exist. As Mr. Donkin put it in his Paper on the "Prospects of District Heating in the United Kingdom," "in existing towns the roadways and footways are already congested with other services, such as water, gas, electricity, telephones and little space is left for conduits for heat distribution pipes," though he insisted that the opportunity presented by the planning of new towns to alter this state of things should not be lost. He discussed the complications arising out of the combination of heat service with electric generation and suggested that the difficulty of the non-coincidence of the two loads should be solved by the authorities supplying heat and hot water erecting their own heat-electric generating station and selling their surplus electricity to the neighbouring electricity undertaking. And he discussed the use of the heat-pump and heat accumulators in dealing with these problems.

These papers were followed by a "Memorandum on District Heating as applied to Small Housing Estates," issued by the Ministry of Fuel and Power and by descriptions of the projects for Wythenshawe (Manchester) and Urmston. There was also a Paper on "Continental Practice" written by Mr. Margolis, who has had actual experience in Hamburg. We shall deal with these later.

Now there are several points which should be noted in the whole. In the first place we have in gas supply a form of district heating in being with a long successful record behind it, with no loss of heat in transmission, and with no practical limitation of temperature at the point of use.

In the second place there is not one of the many advantages claimed for district heating—the elimination of smoke and dirt and labour and the saving of coal—which would not equally accrue from the wholehearted adoption of gaseous fuel for all purposes of space heating, hot water supply, and, by the way, cooking. The additional advantage of gaseous heating is that it includes the service of topping-up and it leaves the poor householder in a position "to make desperate economy" by turning off the tap.

"Costs at the present moment are so uncertain," says the Memorandum, that "it is unwise to press the comparison too far." But if a gas undertaking was in the fortunate position of serving a district where every householder used gas to the full extent of his heat requirements it would certainly have no difficulty in undercutting most of the figures given in these papers. Indeed, one undertaking at least has tabled an offer to supply a small township with gas and coke at a flat weekly rate which is competitive with the Wythenshawe figure with topping-up and all the rest of it added.

The President of
The Institution of Gas Engineers
Mr. G. C. Pearson *and* Mrs. Pearson,
send to all members of the Institution and to other friends in and connected with the Gas Industry their Cordial Greetings and Best Wishes for Christmas and the New Year

This is not a technical problem. It is a sociological one. For many years the Gas Industry has offered the public a heat service with all the advantages claimed by the new proposals—and more. Not only does the all-gas solution of this problem eliminate smoke, dust and dirt and the domestic labour entailed in the service of the open fire—but it does this in one set of mains and with a flexibility which far outstrips that of a mere service of hot water. Why then should the public accept the new solution while it rejects the existing one? The answer is simple. The public, in the new towns and districts where the new solution is to be supplied, is to have no choice in the matter. Hot water supply is to be laid on with water and sewerage and the cost of it is to be compulsorily included in the rent. It is safe to say that if gas supply could secure equivalent terms it would solve the problem at a lower cost. But will the public, to any large extent, concede these onerous terms to either form of supply? We doubt it. Rents are already high. Will they stand the addition of even 6s. 11d. (the Wythenshawe figure) to which must be added two or three shillings to cover the cost of cooking and topping-up? The Gas Industry has stood out for the consumer's freedom of choice in the confidence that it can win in any form of fair competition. The imposition of "District Heating"—the compulsory use of hot water, for a part only of the domestic demand of heat—should be resisted.

CONTROL OF PURIFIERS

OPERATION and control of oxide purification by Mr. Norman Biggs, of Halifax, which will be published in full in next month's issue of "GAS," is an excellent example of the sort of Paper which should be written and discussed by members of the Junior Associations. The Paper goes into detail, and deals with the details which are the proper business of the Junior. With oxide, as with other granular substances, such as, for instance, coal and coke, lack of homogeneity leads to difficulties in chemical control, and we should have expected to see something in the Paper about sampling. Assuming the sample is representative the tests and definitions outlined by Mr. Biggs would appear to give an idea of what a new batch of oxide can do. The Author did not go into the vexed question of the dimensions of the box or the bulk of oxide required to deal with a particular quantity of gas or to remove a given quantity of sulphur. Considerations of the design and proportioning of the purification plant as a whole were no doubt outside the scope of his Paper, though the scope is wide enough. It covers every phase of control from the new oxide to the spent, filling and emptying, air and steam admission, temperature and humidity control—everything, in short, that would come within the sphere of action of the technical assistant in charge of purification. But we fear that the practice of having a chemist or technical assistant in charge of all purifier operations is only "usual" in works of the size of Halifax and over. In by far the greater number of works these duties must be fitted in with many others. This "simple operation" is too often left to look after itself—at any rate until the acetate paper is stained. In many works air admission is a haphazard business. Hence we are glad to see the subject treated so carefully in Mr. Biggs' Paper. When we turn to temperature control, the rule, "as low as one can and as high as one must," seems a good one. Tar fog, that bugbear of the purifier, appears to be abolished by the electrostatic tar precipitator, but we wonder whether the effect is as good when the detarrer is placed on the hot gas (as recommended for the purpose of liquor treatment) as when it is placed after the exhauster.

The Paper to which we refer is good—a complete essay on a most interesting and important subject. We shall not, we hope, be deemed ungracious if we say that it could have been much improved by a little more attention to written English language. A great writer has said that the best style is characterized by lucidity, simplicity, and euphony. The last-named may have to be dispensed with in a scientific or technical paper, but insistence should be laid on the first two. Such a sentence as "What tests are made should be done to show how the plant is working to detect inefficiencies, giving a useful record and not merely an accumulation of figures," could be vastly improved in lucidity by being cut into two or three simple sentences.

FOUNDATIONS

PROBLEMS arising out of the necessity of erecting heavy gas-works plant on made ground or soil of poor bearing quality are fairly common. In a Paper to the London and Southern District Junior Gas Association, which will be published in "GAS" next month, Mr. F. Ward mentioned a number of the considerations involved. The reclaimed land at Pitwines Works, at Bournemouth, and the "marine marsh" type of ground at Poole may be regarded as typical. They will stand only light loads on the top and piles must be driven to a considerable depth to get a set for heavier loads. The question whether the weight of the concrete foundation should be added to that of the superimposed structure in calculating the load to be borne by the subsoil has often been argued. It is certainly on the safe side to do so but it may be urged that the sub-soil has already borne and been consolidated by the weight of the excavation which therefore might reasonably be subtracted from the gross load.

The reinforced concrete raft is a useful device to spread a load over a sufficient area. It is important when point loads are irregularly distributed over the raft to proportion the raft in plan so that the resultant load is near the geometric centre so that the inevitable subsidence may be equal at all points, keeping the raft horizontal. Rafts have been greatly improved and settlement reduced by the use of sheet piling round the edges which prevents the sub-soil from spreading or "flowing' from under the raft. In one very successful foundation for a vertical retort installation erected on land of this type, sheet piles were first driven round the area to be excavated for the raft. They served in the first instance as shoring. The ground was then excavated and the raft constructed, after which the sheet piles were driven with their heads a short distance above the bottom of the raft. They then served to prevent the spreading of the sub-soil.

The instances of the gasholder tank and the foundation for the vertical retorts briefly described by Mr. Ward are of considerable interest. It is certainly advisable to consult engineers who specialize in this class of work. The use of the pre-cast pile is somewhat discredited these days. It is necessary to drive a test pile to ascertain the probable length required and then this length must be exceeded to secure a good job with the subsequent necessity for the troublesome work of cutting away the excess. There are several excellent systems of piles cast *in situ* of which Mr. Ward described the type using a steel tube. Concrete tubes in sections driven on a steel mandrel have the advantage that the interior of the tube can be inspected before filling with concrete and reinforcement. The risk of injury to nearby structures by the vibration of the pile driving may be obviated by the use of one or other of the pressure-driving systems. One would think that pile testing should not be necessary if a sufficient set is insisted upon.

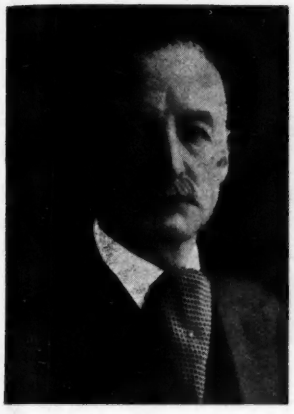
The use of reinforced concrete in gas-works buildings and structures has much to commend it. Its freedom from corrosion, provided that the precautions mentioned by Mr. Ward are conscientiously taken, is sufficient to render it most desirable. There are difficulties, of course. At the present time the dearth of timber makes shuttering expensive and slow. Perhaps, however, the biggest difficulty is that of allowing for expansion and contraction both in maturing and in working conditions to avoid cracking. With care, concrete and reinforced concrete can be used to produce buildings

and structures on a gas-works which, as Mr. Ward said, "while serving a useful purpose, do not offend the eye." But a cracked concrete bunker with rust stains running down it can offend the eye as much as an unpainted steel frame. Attention to maintenance in both classes of work can do as much to prolong life as to redeem a gas-works from a dilapidated appearance still too common.

Personal

Mr. Henry Woodall

Mr. HENRY WOODALL, whose retirement on Dec. 31 from the post of Deputy Governor and from the Court of Directors of the Gas Light and Coke Company has just been announced, was appointed a Director of the Company as long ago as 1913, and became Deputy Governor in 1926. He was an original Director of the South-Eastern Gas Corporation, Ltd. Since the day, more than 60 years ago, that Mr. Woodall entered the office of his father (Sir Corbet Woodall) in Westminster, he has been actively engaged in work in connexion with the Gas Industry. The firm of Corbet Woodall & Son had a large practice as Consulting Civil Engineers which extended throughout the United Kingdom and to many parts of the world, and it was in this connexion that Mr. Woodall travelled extensively supervising the erection and control of gas-works. His firm were Consulting Engineers to the Imperial Continental Gas Association, and at one time they were looking after works in Vienna, Amsterdam, Copenhagen, Antwerp, Brussels, and in Berlin—to name only a few. Mr. Woodall visited all these places on his firm's behalf and in those days travelling was not as swift as in these days. In addition Mr. Woodall spent two years (1886-1888) in Australia and two years in South Africa (1893-1895). Corbet Woodall & Son had a considerable practice in the Parliamentary Committee Rooms and Mr. Woodall was frequently called in to give evidence in connexion with Private Bills before both Lords and Commons, and his services were often in demand as an arbitrator or as an expert witness in arbitration. He took part in many important rating cases. Mr. Woodall holds, among others, Directorships in the British Gas Light Company, Ltd. (Chairman and Managing Director), Tottenham & District Gas Company (Chairman), Croydon Gas Company (Deputy-Chairman), Ipswich Gas Light Company (Chairman), and the Danish Gas Company (Chairman). He is a member of the Institution of Civil Engineers and of the Institution of Gas Engineers, and has been a Magistrate for Kent during the past 35 years. The Directors of South-Eastern Gas Corporation, Ltd., also announce with regret that for reasons of health Mr. Woodall will be resigning his position as a Director of the Corporation at the end of the year.



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Mr. LESLIE HARDERN, Public Relations Officer to the Gas Light and Coke Company, has been appointed to the General Committee of the National Housing and Town Planning Council.

* * *

Mr. R. V. HART, formerly with the Westhoughton Consumers' Gas Company and latterly with the Llynvi Valley Gas Company, has received an overseas appointment, and is soon to leave for Grahamstown, South Africa, to take up service as Engineer and Manager with the South African Lighting Association.

* * *

Mr. K. G. PEMBERTON, Deputy Works Superintendent to the Torquay and Paignton Gas Company, has been appointed Engineer to the Devon Gas Association. Mr. Pemberton received his early training with the Sligo Gas Company, Eire, and later held appointments as Assistant Manager to the Martock and District Gas Consumers' Company, and Assistant Manager and Secretary to the Totnes and Bridgetown Gas Light and Coke Company.

* * *

Mr. DANIEL MARSHALL, Engineer and Manager of the Burntisland Gas Department, has been appointed Deputy Engineer and Manager of Paisley Gas Department. He succeeds Mr. A. Facer, who has been appointed Engineer and Manager at Hereford. This appointment brings together two Perth men who were trained under the late Mr. David Vass at Perth. The Engineer and Manager at Paisley is Mr. James Dow, who studied with Mr. Marshall before the latter went to Hong Kong in 1929. When he returned to this country in 1938, Mr. Marshall was appointed to Burntisland and he has been there since. At that time Mr. Dow was Manager at Kirkcaldy, so that they were virtually neighbours.

* * *

At the end of December Mr. C. A. MASTERMAN, M.A., terminates his appointment as Chief Technical Officer with the Gas Light and Coke Company. He joined the Company in 1927 to work at the then newly-formed Watson House. Later he became Chief Technical Officer and was in charge of Watson House during the time it was developed as the research, testing and training centre of the Company (the largest of its kind in the Gas Industry). During this period Watson House became well known in respect of its activities in the improvement of gas appliances and fittings and in the technique of gas practice and fuel usage in general. In 1940 Mr. Masterman was seconded to become an Assistant Director at the Ministry of Supply, and later at the Ministry of Fuel and Power, but returned to the Gas Industry in 1943 as Convenor of the Post-war Planning Committee of the British Gas Federation on the death of Mr. Stephen Lacey. He was a member of the Egerton Committee on the Heating and Ventilation of Buildings and gave evidence for the Gas Research Board to the Simon Fuel and Power Advisory Council. Early in 1945, at the request of the Foreign Office and with the permission of his Company, Mr. Masterman became Controller of the Fuel and Power Branch of the Allied Commission for Austria. He has for over a year been working chiefly in Vienna on fuel, power and housing problems and in negotiations on these matters with the Russians, Americans, French and the Austrians themselves. He recently returned to London on the completion of this appointment.

Letter to the Editor

The Le Flueve System

DEAR SIR,—I was interested to read a letter from Mr. Fox, of Messrs. W. J. Jenkins & Co., Ltd., in your issue of Nov. 20.

Mr. Fox queries a statement in your editorial that the only wear in this system is to pumps, and goes on to add, the cost of renewal of trough linings, covers, &c., are not inconsiderable items.

I am afraid my experience definitely does not support Mr. Fox's viewpoint. Having had experience of both the drag bar conveyer and the Le Flueve conveyer, there is no question in my mind as to which incurs the higher maintenance costs. As a matter of interest, it has recently been necessary to make an alteration to the Le Flueve conveyer installed at the New Southgate Works approximately six years ago, and it was found that the blue lining tiles showed very little measurable wear, and so far as can be seen from present experience, these tiles are likely to have a life of 10 to 15 years, though of course, time alone will confirm this estimate.

The capital cost of the Le Flueve system is undoubtedly higher than that of an equivalent drag bar conveyer system, but from the point of view of working conditions, which are of no little consequence, and in particular, reliability, in my opinion the drag bar system cannot compete with the Le Flueve system.

With the Le Flueve system, the only working parts are, of course, the pumps, and with these in duplicate one has, for all practicable purposes, a duplicate conveyer system.

The writer would assure Mr. Fox that a few years living on the works with both systems would soon convince him as to which of the two was the most reliable and trouble free.

Mr. Fox asserts that the Le Flueve system requires close control to maintain a low moisture content of the quenched coke. I would say this applies to any system of wet coke quenching.

There are, of course, drawbacks with the Le Flueve system, and one of them, in particular, is the difficulty of controlling the moisture content of the coke, there being a tendency for smalls to get over quenched, and the large sizes insufficiently quenched. This state of affairs also exists with a drag bar conveyer.

This question of moisture content, I suggest, is all bound up with the question of time contact, which is consequent upon rate of water flow, length of conveyer and its rate of fall, also the arrangement for separating the coke from the water at the discharge end of the conveyer is of no little importance.

Naturally, this drawback is most pronounced, as Mr. Fox suggests, when dealing with coke from low rank coals, which confirms what the writer has felt for a long time, that each installation must be designed, taking into consideration local conditions—*e.g.*, number of settings to be served by the conveyer, and in particular, the type of coal being carbonized.

In conclusion, despite the drawbacks which the system undoubtedly has, until a system, better both technically and economically, for dealing with hot coke from horizontal retorts has been evolved, I would assert that the Le Flueve system has, generally speaking, much to commend it when compared with other recognized methods of handling hot coke from horizontal retorts.

Yours faithfully,

C. A. DEAS.

Gas-works,
New Southgate, N.11.
Dec. 6, 1946.

Home Planning at Dundee

The Home Planning Exhibition, sponsored by the British Gas Council, which will be on show to the public in certain towns in Scotland, was officially opened in the Victoria Art Galleries, Dundee, on Dec. 9, by Lord Provost Powrie.

Mr. E. Douglas, Gas Convenor, who presided, said that the planned kitchens in the exhibition were designed to avoid waste of fuel and labour, which was only too common in many houses. The equipment on view was not yet available for the general public, although he hoped it would be soon. It was going to housing schemes and reconditioned houses.

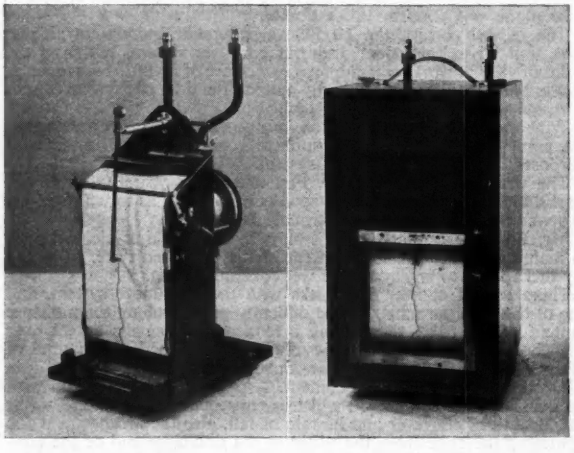
The Lord Provost paid tribute to the up-to-dateness of the Gas Department, and to the Gas Industry for its efforts in face of the coal shortage. Since Dundee Corporation gas showrooms were opened in 1936, privately owned domestic gas appliances had increased by 18,367, and industrial appliances by 1,000. The annual consumption of gas had risen from 1,785,000,000 cu.ft. to 2,050,000,000 cu.ft—and it was still rising.

Mr. David Fulton, Chairman of the Scottish Management Committee of the British Gas Council, said that the Ministry of Fuel and Power had urged that, in the interval of waiting for nationalization, the development of the Industry must not cease. That had been taken to heart. It was claimed that nationalization was more efficient, but what he feared was that they would lose the local and personal interest from the people they knew, and with whom they lived. Despite shortages, the Gas Industry intended to maintain its reputation of more than a century, for never letting a consumer down.

Dundee housewives will have an opportunity of entering their favourite recipes for a competition. Mrs. Jennifer Ellis, London, is preparing a cookery book of local recipes, and by organizing a competition Dundee Gas Department are lending a hand.

A Recorder Without "Frills"

A new recorder has been introduced by the Metronic Instrument Co., Ltd., Smethwick. The aim has been to produce a movement of utmost simplicity, devoid of all "frills," and readily understandable by the user. The illustration depicts the instrument fitted with a continuous chart—*i.e.*, the ends being gummed together. The chart is driven by a clock contained inside the upper drum, and chart tension is provided by a spring balanced lower roller. The pen moves across a writing table, and is thus able to give a perfect recording in any position. The nickel silver pen arm is fitted with micrometer screw for adjusting pen pressure. During chart changing the lower roller is raised and is then automatically held up. The pen is held away from the chart by a lever fitted with toggle movement.



The non-portable recorder on wooden base *Fitted as portable recorder in wooden case*

The standard chart is 6 in. wide, but charts up to 12 in. wide can be arranged for. Available chart speeds are ¼ in., ½ in., ¾ in., 1 in., 1½ in., 2 in. and 3 in. per hour.

The recorder may be fitted with one or two pens for registering the movement of pressure and/or flow units fitted behind the recorder. The illustration is of a portable differential recorder having a mercury U-tube movement giving a differential of 20 in. w.g. and tested for static pressure of 200 lb. The mercury float movement is transmitted through a magnetic system to the pen gear. The magnetic transmission is of such strength that it is virtually positive; any attempt to hold up the magnets by forcibly moving the pen arm would result in lifting or sinking the float.

A modification of this instrument allows for the use of a monthly roll chart, in which case the recorded portion of the chart is automatically picked up by the lower drum which winds it up. The chart may be cut off either above or below the pen as required and is very easily drawn from the winding drum. Sides of the chart are perforated and engage in pegs on the driving drum. Provision is made for adjusting the time setting. Non-portable instruments are contained in steel cases finished stoved black crackle enamel with chromium fittings.

A Splash of Colour

An interesting splash of colour has recently been added to the Grimesthorpe Works of the Sheffield and District Gas Company, apparently to the envy of the L.M.S. main line drivers. The colour scheme of the new locomotive which has been named "*Ralph Halkett*" conforms to the L.M.S. Caledonian line, being light blue relieved with maroon and silver.

"*Ralph Halkett*" *at Work*

It was noticed at the time this photograph was being taken near to the main London-Glasgow line, that it attracted the attention of main line drivers and firemen who spared a brief moment to wave their hands in friendly greeting when passing.

Diary

Jan. 7.—Institution of Chemical Engineers: "Chemical Engineering Aspects of the Fischer-Tropsch Process," C. C. Hall and A. H. Taylor. Burlington House, 5.30 p.m.

Jan. 8.—Institute of Fuel (North Western Section): Discussion of Reports of Coal Industry Joint Fuel Efficiency Committee; opener, R. G. Evans. Engineers' Club, Manchester, 2.30 p.m. (Luncheon, 1 p.m.)

Jan. 10.—London and Southern District Junior Gas Association "Consumer Service—Deeds, not Words," J. A. Marwick. Gas Industry House, 7 p.m.

Jan. 11.—Scottish Junior Gas Association (Eastern District): Short Paper Day.

Jan. 13.—Women's Gas Council: Executive Committee, Gas Industry House, 1 p.m.

Jan. 14.—Midland Junior Gas Association: "The Distillation of Tar and Benzole," Roland Scott (Midland Tar Distillers, Ltd.).

Jan. 15.—B.G.C. Domestic Development Committee, Gas Industry House, 2 p.m.

Jan. 18.—Manchester and District Junior Gas Association: "Corrosion on Gas-works," A. J. Brandram (United Kingdom Gas Corporation).

Jan. 22.—London and Southern District Junior Gas Association: Visit to Neasden Works of Ascot Gas Water Heaters, Ltd.

Nottingham City Council has approved the installation at Basford works of new coal gas plant, costing £250,248, and carburetted water gas plant extension at a cost of £45,278, a total of £295,526, and the borrowing of £300,000 to cover the cost. Alderman J. B. Griffin, Chairman of the Gas Committee, has told the Council that at present they were buying gas from Derby at a higher price than that at which they were able to sell it to slot consumers. The Gas Committee had decided it was a matter of extreme importance and urgency that the new gasmaking plant should be obtained without delay, and it had been decided to place the orders at the first possible moment. The Ministry of Fuel and Power had expressed satisfaction with the proposals to buy the new plant, which would fit in with the Minister's scheme when nationalization took place.

New B.G.C. Committees

The British Gas Council has appointed five Publicity Planning Committees (Advertising; Editorial; Exhibitions; Films; Publications) and a Publicity Executive Committee. Consequent upon this the Publicity Committee has been reconstituted, the new membership of which is as follows:

A. B. Seton, Chairman (London District), T. Brown, Chairman, Domestic Development Committee (*ex officio*), H. R. Hems, Chairman, Industrial Gas Development Committee (*ex officio*), F. Allen (Eastern District), C. H. Bamber (North Western), W. A. Bishop (London), D. Fulton (Scottish), L. H. Hardern (London), S. Hopkinson (North Western), A. L. Morris (Midland), W. R. Oliver (Yorkshire), R. Prince (Southern), Noel S. Smith (South Western), S. Smith (Southern), R. Snelling (South Wales), A. E. Tullberg (Southern), J. White (Northern).

The Publicity Executive Committee comprises the Chairman of the Publicity Committee and the Chairmen of the Planning Committees, *ex officio*, namely: A. B. Seton (Publicity), A. E. Tullberg (Advertising), D. Fulton (Editorial), W. A. Bishop (Exhibitions), S. Hopkinson (Films), L. H. Hardern (Publications).

The Publicity Planning Committees are:

Advertising: A. E. Tullberg (Chairman), A. B. Seton (Chairman, Publicity Committee, *ex officio*), W. R. Oliver, T. Smith, R. Snelling.

Editorial: D. Fulton (Chairman), A. B. Seton (Chairman, Publicity Committee, *ex officio*), F. A. Cheeseman, R. Prince, S. Smith.

Exhibitions: W. A. Bishop (Chairman), A. B. Seton (Chairman, Publicity Committee, *ex officio*), S. Hopkinson, N. S. Smith, J. White.

Films: S. Hopkinson (Chairman), A. B. Seton (Chairman, Publicity Committee, *ex officio*), C. H. Bamber, M. O. Coates.

Publications: L. H. Hardern (Chairman), A. B. Seton (Chairman, Publicity Committee, *ex officio*), M. O. Coates, A. L. Morris, R. Prince.

This new committee organization at Gas Industry House is designed to transfer much of the detail work to the respective specialized Planning Committees, leaving the Publicity Committee free largely to concentrate upon decisions concerning policy and finance, and the Publicity Executive Committee to deal with matters of emergency and items referred to it.

British Standards for Workshop Practice*

"British Standards for Workshop Practice" (B.S. Handbook No. 2) was first issued in 1943 at a time when British industry was intensively engaged in armament production. The quantity of non-standard tools and gauges which were then being ordered was a matter of grave concern to the Government Supply Departments, and it was obvious that lack of the universal adoption of British Standards was costing the country millions of man-hours of skilled labour and was resulting in serious delays in production.

It was therefore suggested that the essential data from the various British Standards applicable to engineering workshop practice should be gathered together and published in one convenient volume, so that every engineer concerned with design or manufacture might have readily available to him the standard data in a concise and handy form.

The publication, at a popular price, of such a handbook, which included the essential data from 40 British Standards, was in the nature of an experiment. That it was successful has been proved by the continued and constant demand for this volume, of which three impressions of the first edition have been published.

Modifications which have been made since 1943 to certain of the British Standards reproduced in the Handbook have made necessary the issue of a completely revised edition, for it is an essential that a reference work of this character should be up to date.

The Handbook reproduces the essential technical data, diagrams, and dimensions from 40 British Standards relating to limits and fits; screw threads, including metric threads and some information on American threads; pipe threads; designs and tolerances for plain and threaded gauges; bolts, nuts, machine screws and washers; small rivets; small tools such as screwing taps, milling cutters, reamers and drills; drilling jig bushes; butt-welded lathe and planer tools; keys, keyways, coned-end shafts, splines and serrations; ball and parallel-roller bearings; and certain details of machine tools, such as milling machine spindles, lathe spindle flanges, and spindle noses for grinding machines. In addition there is a section giving extensive data on cast iron and steel, while some useful general tables are included relating to hardness numbers, wire gauges, and metric conversions.

The economies in time and in cost of manufacture that can be obtained by adherence to standards cannot be denied, and in his introduction, Sir William Stanier, Chairman of the Mechanical Engineering Industry Committee of the Institution, points out the advantages of having the particular specifications required by an individual industry brought together in the form of a handbook, and expresses the hope that industry will utilize these handbooks to an even greater extent.

* *B.S. Handbook No.* 2 (pp. 483, 12s. 6d.), with an Introduction by Sir William Stanier, F.R.S., Hon.M.I.Mech.E. General Editor J. E. Baty, M.I.Mech.E., M.P.I.E., A.M.I.E.E.

Chemical Society Centenary

As part of the centenary celebrations of the Chemical Society an exhibition illustrating the achievements of British chemistry during the past century and the part which chemistry plays to-day in everyday life is to be held at the Science Museum. The exhibition, which will open in July, 1947, is being organized by the Chemical Society and the Department of Scientific and Industrial Research in two galleries which have been lent by the Science Museum.

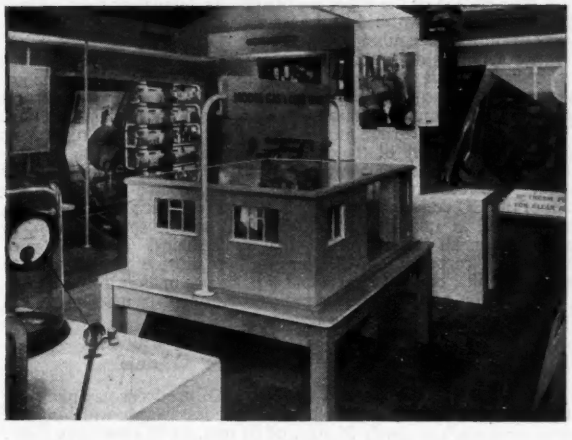
The Chemical Society is preparing the first part of the exhibition which is to be a historical exhibition illustrative of the great advances that have taken place during the hundred years of the Society's existence. How great are those advances will be noted when it is realized that, at the foundation of the Society, Dalton's Atomic Theory was but 30 years old; the study of organic chemistry, as we know it to-day, was in its infancy. Fellows of the Society have figured prominently in the development of the science; and the Centenary is an opportunity to arrange a display under one roof of many historical exhibits never before seen together.

Among famous chemists whose work will be illustrated is Faraday, whose discovery of benzene in 1825 paved the way for the production of a host of new substances used in making dyes, drugs, perfumes and explosive materials. The romance of the discovery and preparation of artificial dyes will also be shown, and will include W. H. Perkin's preparation of the first "coal-tar" dye "mauve," discovered in 1856. The story of the familiar electric sign, so much in use to-day, will be taken back to pioneer work on the rare gases of which the red "Neon" light, discovered by Ramsay in 1898, is a spectacular example. The first preparations of artificial rubber will be included and many other interesting objects in the history of chemistry during the past 100 years will be shown. Each branch of chemistry is under the care of a panel of experts who are now engaged in preparing an account of the progress in the past hundred years which this exhibition serves to illustrate.

The Department of Scientific and Industrial Research is preparing a modern section of the exhibition dealing with the applications of chemistry in everyday life. Between the two parts of the exhibition, there will be a linking section which will explain the processes by which the chemical engineer turns raw materials into the products which are familiar in the day-to-day life of every citizen. This will lead on to sub-sections dealing with such themes as textiles, agriculture, homes and buildings, roads and transport, fuel and power, health and food. The D.S.I.R. is having the co-operation of the Agricultural Research Council, various research associations and other organizations in the preparation of these exhibits; and the Central Office of Information is undertaking the design and layout of this part of the exhibition.

A Good Show

A few weeks ago the Hammersmith School of Building and Arts and Crafts made application to the Gas Light and Coke Company for a display to go in the school's entrance hall. The members of the Company's Display Section have given them a very good show, which includes exhibits showing gas manufacture, by-products, and service in the home. There are models of gas-works plant (loaned by Messrs. R. & J. Dempster, Ltd.); a scale model of a modern home; displays dealing with smoke abatement; and some sectionalized gas water heaters. The display, built from scrap materials, is well lighted and has a background mainly in cream.



In the school entrance hall

It is estimated that 3,000 students, architects, and other visitors will see this exhibition during its three weeks' life.

Notable Power Gas Contracts

TWO contracts of considerable technical interest and exceeding £500,000 in capital value have recently been awarded to the Power-Gas Corporation, Ltd., Stockton-on-Tees, by the Dutch Government organization, Staatsmijnen in Limburg (Dutch State Mine)s, under which is operated the great bulk of the coal industry in the Netherlands. The plant and equipment to be supplied are of those types which the Power-Gas Corporation has specialized in developing over many years past.

The larger project is to manufacture gas for ammonia synthesis. Capacity is equivalent to the production of 180,000 tons ammonium sulphate annually for fertilizer purposes. The installation comprises four main sections for continuous operation 24 hours per day throughout the year, viz.: (1) The gas generating plant, *using oxygen*, (2) carbon monoxide conversion plant, (3) carbon dioxide removal plant, (4) final carbon monoxide and carbon dioxide purification plant.

The gas generating plant will use 180 tons per day of coke sized 60 to 80 mm. The gasification process, however, is such that fuel grading is immaterial (unlike the ordinary water gas process) and whether the coke size be 15 to 25 mm. for instance, depends simply on what is most economically available. A feature of special interest is that oxygen will be used in the fuel gasification, with a gasification efficiency considerably increased over standard water gas practice. The expected working costs in this use of oxygen have been investigated thoroughly, and the Dutch State Mines are themselves installing an air-separation oxygen plant especially for the purpose of providing the necessary oxygen which the gasification process requires.

Gas Making Plant

The gas making plant will comprise four generators, each to gasify 60 tons of coke daily and the gas produced will have approximately the following composition:

CO_2	CO	H_2	N_2	CH_4 + A
9.0	41.5	26.0	22.5	1.0

With this use of oxygen, the gasification efficiency is greatly increased over the ordinary water gas process, and will be about 85%.

The gas produced, some 18,000,000 cu.ft. per day, will be treated with steam over a special catalyst in the second section for conversion of carbon monoxide, according to the well-known reaction: $CO + H_2O \rightarrow CO_2 + H_2$. The volume of converted gas is about 40% greater than that from the gas generating plant, the quantity of hydrogen and of CO_2 being increased.

CO conversion plants have been built by the Power-Gas Corporation for 15 years past, in units of various sizes, and in several parts of the world. The catalyst currently employed however has been developed in P.G.C. laboratory researches during the past year to work at high efficiency, with the maximum conversion of carbon monoxide using the minimum quantity of steam at the lowest possible temperature.

The first stage of CO_2 removal is attained by scrubbing the gas with water, under a high pressure of about 190 lb. per sq. in. The water pressure is released in a water turbine for recovery of power, the water turbine being connected on the same shaft as the main water pump and its electric motor. On release of pressure, the greater part of the absorbed CO_2 is released, and can be collected for use elsewhere. A final regeneration of the water is obtained by circulating over a tower up which air is blown, before the water is taken by the pump for delivery again to the scrubbing tower.

In the synthesis of ammonia, harmful impurities must be of a very low order, and this applies particularly to CO, CO_2 and O_2. The gas is compressed to a much higher pressure (1,800 lb. per sq. in.) and scrubbed with a liquor containing copper-ammonium salts in solution. This liquor absorbs carbon monoxide and also any traces of oxygen, as well as a great part of the residual carbon dioxide. The copper-ammonium liquor is regenerated by a special treatment, for use over again. The recovered carbon monoxide is of course returned to the inlet of the CO conversion plant. The final treatment is by scrubbing the gas, still at 1,800 lb. per sq. in., with caustic soda solution, to remove the small amount of CO_2 that still remains. In this stage of purification, carbon monoxide and carbon dioxide are reduced to very fine limits, below 15 parts and 5 parts per million, respectively.

Each section of the plant is complete with ancillary machinery, and gasholders are provided where necessary.

Producer Plant for Coke Ovens

The second contract is for a large modern producer gas plant for firing a big new battery of coke ovens. The installation will comprise seven units, each to gasify 50 tons of 60 mm. to 80 mm. coke daily. In this case, too, the fuel most cheaply available is selected, for these gas producers can work equally well with material sized say between 15 and 25 mm. The producer gas process is one in which the Power-Gas Corporation, Ltd., has specialized for nearly 50 years, but this latest development incorporates new features to gain extra efficiency, as for instance preheating of the air and steam blast, and the use of automatic control to ensure constancy and regularity of operation with a minimum of attention. The gas will be cleaned to a high standard of cleanliness by means of disintegrator gas washers.

Great Wastage of Time

COLONEL W. Moncrieff Carr, Managing Director of the United Kingdom Gas Corporation, gave an address on "The British Gas Industry" to the North Western Fuel Luncheon Club at Manchester on Dec. 4.

"The Industry," he said, "has experienced during the past 18 months the restrictive effects of Governmental control operated under the War Defence Regulations, some of which has no doubt been necessary. It has resulted in great wastage of time by senior executives in the preparation of information for Ministerial officers who are, without exception, most desirous of being helpful, but the machinery of Government is such that it does not provide for the ready acceptance of responsibility by its officers whose primary function is to assist in the drafting and administration of the law."

Reviewing the history of the Industry, Colonel Carr said it was only during the last 40 years that gas had come into extensive use for industrial purposes. The supply of gas to industry had rapidly increased in the last decade, and in some undertakings supplying industrial areas, the quantity of industrial gas sold was considerably in excess of that for domestic purposes. The necessity for accurate control of heat treatment, and increased factory production, had led manufacturers to purchase their heat requirements on tap, and the use of coal in its raw state in many heat treatment processes was not only unscientific, but uneconomic. The conservation of the national coal resources must envisage the carbonization of all available gas and coking coals, much of which was still being consumed in domestic open grates at, approximately, one-third the efficiency in use.

The process of integration of gas undertakings had continued throughout the life of the Industry by the extension of existing areas and amalgamation of units. It had been greatly assisted in the last decade by the operation of holding companies (for one of which Colonel Carr is responsible). Not only had considerable advantage been obtained by the grouping of units under central management enabling the centralization of distribution and consumer services for such groups, but small undertakings which did not lend themselves to grouping, were helped by expert advice, and technical assistance from the parent body. In certain areas integration could produce economies; if it was carried too far, the reverse could be the case, and an operating unit should be of such size that its services could be brought within the scope of those responsible for operating it.

The West Yorkshire Grid

A unique development in gas supply was the West Yorkshire Gas Distribution Company, which was set up to co-ordinate gas supplies in the West Riding by the construction of a grid to collect gas from existing and new coke ovens, and the most efficient gas-works, for supply to gas undertakings. The Company did not supply to consumers, but existed only for the bulk purchase of, and the sale of gas to and from gas undertakings. The Company served gas undertakings in a densely populated area with a wide variety of industries. The scheme had resulted in substantial economy in production and distribution. The limiting factor of this type of development was the load factor, and the density of population; it rapidly became uneconomic if there was any considerable distance between undertakings. The grid operated on the highest gas pressure utilized in this country, *i.e.*, 35 lb. per sq. in., and compression costs increased out of proportion to any saving in mains capacity if higher pressures were employed. Therein lay the difference as between the grid distribution of gas and electricity; electricity could be most efficiently generated at high voltage for distribution over considerable distances whereas gas had to be compressed at considerable cost for high pressure transmission.

Referring to the Heyworth Report, Colonel Carr said it had been suggested that the work of the holding companies had proved the case for extended integration and bulk distribution of gas over wide areas, but it should be clearly understood that such schemes had proceeded only after detailed investigation had proved their advantage to the community whose goodwill was a gas undertaking's sole asset; in short, the over-riding considerations must ever be the provision of cheaper and better service.

A Bill for the nationalization of the Gas Industry was in course of preparation. It was not known what form the Government's proposals were likely to take, but it was most desirable that if the plan provided for regional organization, its purpose should be one of survey of the existing undertakings, and the preparation of schemes of integration, to ensure that no proposed new unit of supply was created which was less efficient than the existing structure which it would replace; in other words, if an attempt was made to form new operational units without such survey, it was inevitable that it would result in dearer gas.

Gas Output at Accrington in November was 30% higher than in the corresponding month of last year. The increase for the past seven months has been 12%. Suggested reasons for the increases are the shortage of household coal and the reversion to British Summer Time in the summer months and to Greenwich Time in the winter.

Junior Associations' Activities

IN order that non-Junior readers of the "JOURNAL" may have a glimpse of the sayings and doings of the Juniors we give below a brief glance at the contents of this month's issue of "GAS," our monthly record of the British Junior Gas Associations.

Distribution at Gloucester

A four-fold increase in gas consumption at Gloucester in the present century has been accompanied by corresponding developments in the distribution system. In 1934 the undertaking was acquired by the Severn Valley Gas Corporation, and since that time the supply has been linked with Cheltenham and Stroud, modern control systems have been introduced, and preparations made for further developments in the future. Extensive building development is planned around the city, and the Town Planning Committee, in conjunction with the Publicity and Development Committee, have allocated areas to attract industrialists to the district. There is every reason to believe that Gloucester will see an increase in gas consumption even greater than in the past.—*W. A. Chard, "Growth of the Gloucester Distribution System," at a joint meeting of the Midland and Western Junior Gas Associations.*

Water Heater Installation

A good water heater should be efficient and utilize as much heat as possible. It should be easy to maintain at a low cost; the burners, if luminous or atmospheric, will always cause a certain amount of deposit. The maintenance fitter should at fixed intervals overhaul and clean thoroughly all parts of the heater. All gas water heaters that are to work in conjunction with any boiler system should be supplied from the cold water tank; on no account should they be subject to mains pressure. Instantaneous heaters cannot be fitted to low pressure systems in certain types of buildings, such as flats, bungalows, prefabricated houses, &c., as it is not possible to obtain the required head of water; in such cases they have to be transferred to mains pressure. Great care must be given to all flues used with gas appliances. Conditions vary in many districts due to weather conditions, badly constructed or choked chimneys or flue pipes, or wind blowing against the terminal of the flue pipe causing down or back draught. Makers of gas appliances have made great strides towards the elimination of down draught with the development of the back draught safety device which has proved most effective in use.—*D. E. Wilkins, in his Presidential Address to the Wales and Monmouthshire Junior Gas Association.*

Reconditioning a Five Million Waterless Holder

A period of 12 months was spent on reconditioning a 5,000,000 cu.ft. waterless gasholder at Coventry, at a cost to the Department of £3,616. First brought into commission in 1930, the holder continued in use until September, 1939, when on the outbreak of war it was put out of action by a direction of the Board of Trade, applicable to all waterless holders in this country. From a hair crack on the exposed side of the concrete foundation a very slight seepage of tar was observed in the summer of 1942. Repairs were carried out and the holder was subjected to satisfactory tests. It has now been continually at work for 14 months, and no further leak has been observed. The sealing tar is in good condition and all the side plates from top to bottom are free from any encrustation of old tar, the pump runs being fairly constant at 30-40 total. Benzole extraction has been reduced, but with the Tooby-Langford treatment plant, treating the tar as it enters the first compartment of the collecting tanks, no serious increase in the seal depths has been encountered. Any slight increase is immediately counteracted by closing the outlet weirs slightly. Apart from these adjustments normal working conditions are maintained.—*D. M. W. White, "Reconditioning a Five Million Waterless Holder," at a joint meeting of the Midland and Western Junior Gas Associations.*

Steaming in Intermittent Verticals

Results of a prolonged investigation of steaming efficiencies in intermittent vertical chambers at Croydon demonstrate how an arbitrary increase in the rate of steaming designed to increase the volumetric output of the plant or to reduce the calorific value may, in fact, give no benefit whatever. For example it would be quite possible to increase the steaming percentage from, say, 4% to 6½% and, as a result, to reduce the efficiency from over 80% to about 50%, so that in fact the same gaseous therms would be obtained for the expenditure of nearly 60% more steam—a loss representing about 25,000 lb. of steam per day on the Croydon plant. The results point generally to the desirability of a comparatively low rate of steaming, say 5% by weight of the coal admitted in two hours being a reasonable maximum. By raising temperatures or by extending the period of steam admission, a greater amount of steam could be gasified, but the first method would lead to a disproportionate increase in fuel consumption and therefore in carbonizing costs, and in considering the second it must be remembered that the greater proportion of coal gas present during the extended steaming time will lead again to a very much reduced decomposition figure. The alternative would be to extend the carbonizing cycle, which would reduce the throughput of coal with a corresponding increase of costs per ton carbonized. The practice of deliberately steaming a charge at a low rate over a considerably extended period is favoured by some engineers, who claim increased thermal yields from the coal due to reduced degradation of the coal gas. It would seem from the data obtained that such benefits must be set against the possibility of wasting as much as 20% more steam as a result of applying it before carbonization is complete.—*R. Whiting and G. O. Turner, "Determination of Steaming Efficiencies in Intermittent Vertical Chambers," at a meeting of the London and Southern District Junior Gas Association.*

Impact of the War Years

The resilience of the Gas Industry to changing conditions has been shown in its history, and has again been proved during the last few years. Outstanding among the post-war needs are the provision of greater facilities for thorough training in all sides of the Industry; the ability to have some choice in the type of coal purchased and some guarantee that its quality would be kept within reasonable margins of the submitted sample; an appreciation of the importance of residuals and of reducing fuel consumption on the works. There has been much material destruction on the works; much strain on overloaded plant and depleted personnel; some relaxations into slipshod methods; some tightening up into improved technique, but certainly a fuller appreciation of the value of light, ventilation, space, and colour to working conditions. The sense of relief which pervaded as the black-out was lifted from each section of plant is one which must not be forgotten. There is yet much to do in this direction, both to existing works and when new plant is being planned. There is neither time nor need for despondency, for we are now facing a period of reconstruction and competition, and it is now that the lessons of the war years have to be applied, even in the face of present-day uncertainties, difficulties and delays.—*J. C. Hogg (Stretford), in his Presidential Address to the Manchester and District Junior Gas Association.*

Evolution of Meter Design

Gas meter development dates from Clegg's realization at the beginning of the 19th century that if gas sales were to be placed on a sound financial basis some form of measuring standard was essential. There was first the volumetric meter, then the inferential, and the proportional meter combined the principles of both. Although constructed on the same broad principles and of the same materials as the original dry meter of a century ago, the modern four-chamber dry displacement meter has evolved through many stages of design and method to the highly efficient, modern prototype—the high capacity meter. If there is not the came longevity in the modern meter there are the compensations of small size, greater throughput with accuracy standardization and consequent simplicity in repair and replacement, and the fact remains that despite the extraordinary advances in wage rates and cost of materials, the gas engineer to-day measures 100 cu.ft. of gas per hour at a metering cost lower than that ruling 25 years ago. It must be remembered that a meter is a measuring instrument and if treated as such it will give long years of accurate service. It is the instrument on which everyone in the Industry relies for his income. High efficiency in the works can be brought to nothing by inefficient metering.—*W. E. Fishwick, in a talk to members of the Scottish Junior Gas Association (Eastern District) on a visit to the New Grange Works of Alder & Mackay, Ltd.*

Education and Training

Bournemouth has gained fame throughout the Gas Industry as the home of the first of the intensive courses for gas engineers arranged by the Institution of Gas Engineers in collaboration with the Ministry of Education and the Ministry of Labour. Apart, however, from taking an important part in the national movement, the Bournemouth Gas and Water Company has run a very successful rehabilitation scheme for its own employees, of whom 250 of varying standards have returned to the district. A description of the scheme shows how the undertaking is attracting recruits of the right type and providing them with facilities for learning their trade and increasing their status.

Miscellaneous

December "GAS" also includes a report of the discussion on T. R. Sawers' Presidential Address to the Scottish Junior Gas Association (Eastern District) on "Distribution Problems at Perth"; the annual meeting of the the Wales and Monmouthshire Junior Gas Association, at which A. Pickard reviewed the educational situation; the annual meeting of the Manchester and District Junior Gas Association and visit to Stretford; the visits of the London and Southern District Junior Gas Association to the G.E.C. Research Laboratories and of the Scottish (Eastern District) Juniors to the New Grange Works of Alder & Mackay, Ltd., and a film evening held by the Midland Junior Gas Association.

District Heating: An Interim Memorandum

IN 1942, a Sub-Committee of the Heating and Ventilation (Reconstruction) Committee of the Building Research Board was appointed "to enquire and report on the desirability of developing in this country schemes for the supply of heat for various purposes, by means of steam or hot water from central sources." The Sub-Committee found that much detailed study was required before any full report on the subject of district heating could be prepared. In the course of this work it has in particular considered in very great detail a large hypothetical thermal-electric scheme, partly with the object of bringing out and elucidating the various problems likely to be met in applying district heating in this country, and partly to provide a yardstick which would enable the merits of other schemes to be assessed.

This work is nearing completion, but it may still be several months before a final report can be published. Meanwhile it has been thought desirable to issue an Interim Memorandum, explaining in general terms what forms district heating might take in this country and what factors have to be considered in such developments, particularly in relation to the possible association of electricity generation with district heating.

Definition and Scope of District Heating

As indicated in the Sub-Committee's terms of reference, district heating has been taken to mean the provision of heating and hot water supply to a number of buildings in a locality by means of a piped service of steam or hot water from a central heating station. It may, of course, be argued that "district heating" can also be provided by gas or electricity, in the sense that either of these forms of energy can be transmitted to buildings and used for heating with the elimination of separate solid fuel burning appliances.

Within this definition district heating systems may vary widely in type and size. At the one extreme a small group of houses may be supplied from a single boiler plant which need be no larger than many of the plants now used to supply single large buildings. At the other extreme the whole of the heat requirements of a large town may be provided from a central station equipped with boiler plant on a scale comparable with that to be found in our largest electricity generating stations. In fact, it is often advantageous to link heat production with electricity generation in thermal-electric stations, the steam being produced at a high pressure and passed first through the turbines and then to the heating system.

Previous Experience in the United Kingdom

There is little or no district heating in use at the present time for domestic purposes in Britain, there being only limited applications in Dundee and a few other places. Several detailed schemes have been prepared, however, among which may be mentioned particularly those for Bristol and the Wythenshawe Estate near Manchester. Illustrative schemes have, moreover, been prepared for the Sub-Committee in respect of the central area of Coventry and the Duddeston and Nechells redevelopment area of Birmingham.

On the other hand, there are some places where steam is sold from power stations for industrial process heating. Among these are Liverpool and Leicester, but in neither city is any extensive transmission or distribution system provided, nor is there any general supply of heat, but only a sale by contract to specific customers.

There are many works which use steam for process or space heating combined with power generation. The largest installation in Britain, and possibly in the world, is that of Imperial Chemical Industries, Ltd., at Billingham-on-Tees, which was designed to supply over 600,000 lb. of steam per hour for process work, either as pass-out or back-pressure steam from turbo-alternator electricity generating plant. There are very many smaller installations, notably in the paper-making industry, in chemical works, linoleum works, textile works, laundries, &c.

In many cases—*e.g.*, hospitals and institutions—steam is distributed from a central boiler house to a number of separate buildings, or relatively small groups of buildings, for space heating, hot water supply, and other purposes.

District Heating Abroad

Abroad, district heating is most highly developed in the U.S.A., U.S.S.R., and Germany. To obtain a correct perspective, however, it should be made clear that the total area served by the distribution systems even in those countries is very small. In the U.S.A. the total length of the distribution systems of the nine largest undertakings is only 211 miles, and the total number of consumers is only 6,409, though this total includes many owners of large blocks of offices, &c., who are classed as single "consumers" even though they may each cover the needs of many individual tenants. In the 10 cities of the U.S.S.R. with the largest district heating undertakings there were in 1939 only 135 miles of mains and 1,063 consumers. In Germany, the 10 largest undertakings have a total of 90 miles of mains and supply 1,693 consumers.

While the number of consumers of the district heating systems abroad is small, the average quantity of heat sold to each consumer is high. In all three countries it is clear that the heat supply is mainly to large buildings such as office buildings, factories, and large blocks of flats, although in the U.S.A. and Sweden there has been successful development of district heating to serve small housing projects.

Generally, it would appear that the experience gained in the U.S.A. and the U.S.S.R. with large-scale district heating is not directly applicable to this country, and the reasons why district heating has been adopted abroad should be examined.

In the U.S.A., where heat demands per acre in some of the cities served by district heating are the highest in the world, the heat and electricity services are usually supplied from separate sources, but in a few instances combined generation of heat and electricity has been adopted. American comment indicates that, in practice, it is difficult to find an economic solution when the balance between heat and electricity supplies is subject to fluctuations caused by the different rates of growth of the two services, and by their seasonal or even diurnal variations, and especially when the heat sales are affected by competition from alternative sources of supply.

The high buildings customary in the main cities of the U.S.A. favour district heating for three reasons. Firstly, a high load density can be attained—*i.e.*, a high heat load per mile of main; secondly, the heat load for each building is much larger than it would be for a lower building on the same site; and thirdly, in high buildings, the saving of the cost of chimneys assumes greater importance.

In the U.S.S.R. the development of district heating has been mainly in the form of thermal-electric schemes serving new and self-contained townships which are not electrically inter-connected. The whole of the housing community and industrial buildings have been specially constructed to take the new service, and the population have had no option but to utilize this form of heat supply.

In many cases the central thermal-electric stations are equipped to burn very inferior local fuel that would otherwise be wasted. This has the effect of conserving oil fuel, and in some cases of avoiding very long hauls of good coal from the Don Basin to such distant cities as Leningrad and Moscow, where the largest district heating schemes are to be found.

It seems clear that in the U.S.S.R. district heating is being developed as part of the planned national economy, with particular reference to the character of the country's fuel and its geographical location. It would appear that there is a good reason to assume that a similar planned national economy in the use of poor coal and in the saving of good coal is equally desirable in this country.

Some General Considerations

The economics of any particular scheme will depend largely on the local conditions such as:

(*a*) Size, shape, and geographical configuration of area considered.
(*b*) Relative amounts, and distribution of domestic and industrial load.
(*c*) Density of building.
(*d*) Proximity of possible sites for the central station to the main thermal load.
(*e*) Local climate as affecting heat demand.
(*f*) Habits of consumers.
(*g*) Difficulties likely to be met in laying pipes.

The prerequisite to the consideration of any district heating project and the design and construction of the best equipment either for thermal-electric or for straight heating stations, is a guarantee that a sufficient heat load will be forthcoming. This may be difficult to obtain from a community brought up on the open fire method of heating—who would presumably expect to continue to have free choice as to heating methods. On the other hand, it might very well be attained to a substantial extent in new housing estates now envisaged, if the houses were equipped during construction with district heating and domestic hot water services.

Apart from small schemes which might be developed in connexion with local authorities' housing programmes, the provision of district heating supplies from either thermal-electric or thermal stations would undoubtedly call for special legislation. Such legislation would confer *inter alia*, powers to break up streets and to install ducts and conduits and powers to charge for heat services.

The principal argument for combining district heating with electricity generating stations rests on the fact that, of the total energy in the coal which is consumed in generating stations, only about 30% is converted into electricity, and the balance, except for that lost by radiation, is discarded as heat in the cooling water. It has often been suggested that this heat could be supplied directly to consumers, through a district heating system. This suggestion is misleading in relation to existing generating stations, which have been designed to give the highest thermal efficiency from an electricity supply point of view, for in these the heat is discharged into the river or cooling towers at temperatures ranging from 70° F. to 85° F., and this is much too low a temperature to be directly applied to district heating, since that service

requires temperatures, leaving the power station, ranging from 200° F. to 275° F., or even higher. Such low-grade heat has, however, on occasions, been applied to assist in the abstraction of certain chemicals from sea water, and also for horticultural purposes.

The fact that only some 30% of the heat of coal is converted into electricity in normal straight generating stations must not be taken as showing that those responsible for their design and maintenance have failed to provide stations of the most economical type, or have in any way lagged behind the best and most up-to-date practice as exemplified by any foreign stations. The loss is unavoidable in straight electricity stations, and the Sub-Committee believe that the electricity authorities in this country have erected and are erecting stations second to none in economy.

The conversion of existing turbine plants to thermal-electric plants would be too costly to contemplate, and would incidentally reduce the electrical output. Additional turbine plants, however, designed to pass out higher-grade heat in the form of steam, could, where practicable, be added to existing power stations, so long as additional boiler plant were also provided, as part of these extensions, to supply the additional steam required for such pass-out sets.

Generating stations which are becoming obsolete, could be adapted for district heating purposes in two ways:

(i) The existing boiler plant could be used directly for district heating purposes; or

(ii) If space allows, the existing boiler plant could be extended and new generating plant of equivalent electrical capacity could be installed in place of or in addition to obsolete plant, capable at the turbo-alternator end of not only generating the same quantity of electricity as before, but being of such design as to pass out steam in a state suitable for district heating purposes.

Since the electrical demand is increasing rapidly, and there is no margin available to deal with it, no reduction in the electrical output of existing stations can be contemplated, and therefore combined stations would have to be either extensions to existing stations or new stations designed specifically for the purpose.

The boiler plant required for a combined thermal-electric station, for a given electrical output, would be larger in capacity than that required at a conventional electricity station. The appropriate generating sets would—it is believed—be of a smaller size and more numerous than those installed at a conventional station, at any rate, in the initial stages of development. The capital expenditure in respect of the construction of a thermal-electric station would be admittedly greater than that required for the construction of a conventional station of the same electrical capacity, as an offset to which there remains the economic advantage due to fuel saving referred to in the following paragraph. The capital expenditure associated with the transmission and distribution of heat, which is a large part of the cost of any district heating system, would be little affected by the character of the central station.

Substantial Saving of Coal

From the national point of view, theoretical considerations clearly indicate that a substantial saving in coal may be expected from the combination, where practicable, of heat and electricity supplies in thermal-electric stations, as compared with the combined amount of coal consumed at separate straight heat generating stations and at electricity generating stations of the conventional type. It remains for consideration what reduction—if any—could be made in the price to the consumer for either service by the adoption of thermal-electric generation in large stations.

District heating could be supplied from smaller heating stations of either the straight or the thermal-electric type, both of which are relatively efficient. As noted above, the thermal-electric station would effect the greater coal saving but its adoption would depend on the extent to which the smaller thermal-electric station could be justified commercially. Experience would indicate that it is most difficult in practice to maintain at all stages of development the necessary close balance between the heat and electricity services, if substantial coal savings are to be achieved. It is agreed, however, that the British Grid may go some way to assist in compensating for this want of coincidence in the two loads.

Another aid in balancing the two services is to store heat in hot water accumulators which can be used when the electricity demand is low. Such methods have been successfully employed in Germany, but apparently are not used in the U.S.S.R. The economics of heat accumulation need careful consideration. The problem of "correct balance" does not arise with straight heat stations and straight electricity generation, as the two services are independent.

With a large thermal-electric station there would not be the same flexibility of siting as with a straight electricity station, since it would be desirable for the station to be not too far removed from the centre of the heat load. At the same time, the economic balance in a particular case might lie with the transmission of heat over distances up to several miles if the advantage of a riverside site for the station were thereby secured.

When two services—heat and electricity—are definitely interlocked, the safety of one is more largely dependent upon the reliability of the other, and hence extra risks to electricity supplies, for example—except where covered by supplies from the Grid—would be inherent in the service supplied from thermal-electric stations. While there is no desire to over-emphasize this aspect of the question, the point should not be overlooked.

Small Thermal Schemes for Housing Projects

The application of district heating on a purely thermal basis to housing projects is a very important aspect of the whole subject. With the present concentration of effort on house building, it seems probable that, for the next few years, the most favourable opportunities for district heating will lie in small thermal schemes intended primarily to serve small houses. Such schemes could do much to improve the amenities in this class of dwelling. There would be a continuous supply of hot water, and during the heating season (probably nine months of the year) the standard of heating in the houses would be very much better than that now attained. There would also be appreciable, and possibly considerable, fuel economy as compared with conventional heating methods. If desirable, the small schemes could readily be incorporated in larger schemes at a later date.

Costs of Heat Supply

The cost per useful therm of heat to the consumer from a thermal-electric station would, it is believed, be lower than that of present-day methods of heating, although possibly not much lower when compared with the possibilities associated with recent advances in the type or types of plant installed on consumers' premises and the methods of firing connected therewith. The supply of heat to the consumer from a number of small straight heat stations which do not require the provision of a main transmission system of inter-connecting pipework might in some circumstances give better economic results than heat obtained from a large central thermal-electric station.

In housing estates, the cost of district heating to the consumer would probably have to be covered by a fixed increase in the house rental, but this increase would be largely, if not completely, offset by the reduction in expenditure on fuel for the ordinary methods of heating. Where houses can be designed to take district heating there is also the possibility of appreciable capital saving by the elimination of flues and space for fuel storage. It must be noted that many tenants in the lower income group have in the past been frugal in the use of fuel for space heating and the impact on them of a fixed additional charge for these extra amenities, incorporated in the rent, will need consideration by the local authorities concerned.

Apart from the benefits of an adequate hot water supply and a better standard of heating, the supply of heat either from independent straight heat stations or from thermal-electric stations would improve the amenities of a replanned town. In particular there would be a considerable reduction in atmospheric pollution, and the elemination of much slow road traffic concerned with the retail distribution of solid fuel and ash removal.

Conclusions

To summarize, in this country an appreciable saving in coal and a better standard of heat service may be achieved by district heating methods, possibly without involving the consumer in increased expenditure for heating. In considering particular schemes comparison should always be made with the modern types of domestic solid fuel appliances, and with the facilities already afforded by the gas and electricity industries.

District heating by means of the thermal-electric system would appear to be particularly suitable for application to reconstructed central areas of large cities where high load density would be available, and especially where there were existing electricity generating stations within reasonable distance which could be extended to provide for such supplies. It is desirable that an area of this kind should be tried out in order that some practical experience of bulk supply can be obtained.

On the other hand, the development of district heating in this country might well proceed along the lines of initiating small heating stations of either the straight heating type, or the thermal-electric type, to supply one or more of the new housing estates or residential neighbourhoods, with populations of 5,000 persons and upwards. If action were taken on these lines, valuable data and experience would be obtained for determining under what conditions large-scale district heating by means of thermal-electric generating stations or large independent straight heating stations could be justified in the future in any given area. Such experiments or developments could be carried out for a moderate capital expenditure and, if desired, could subsequently be incorporated in larger schemes.

Much valuable information should also be obtainable from still smaller schemes, operating on a thermal basis and serving groups of perhaps a few hundred houses. It is known that a number of local authorities are interested in this application of district heating and it would seem desirable that some schemes of this kind should be brought into operation as quickly as possible. Some guidance on this aspect of district heating is being given in a separate memoramdum entitled "District Heating as Applied to Small Housing Estates," to be issued by the Ministry of Fuel and Power and the Ministry of Works.

Corrosion of Water Heaters*

Experiments with Instantaneous Water Heaters

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(Continued from p. 1053)

WHEN the sulphur content was reduced to 0.1 gr. per 100 cu.ft., there was considerable increase in the amount of corrosion. The corrosion deposit was quite different in composition (Table 7), the sulphate content being very low, and the nitrate content being high. Despite the low percentage of sulphate, the proportion of the sulphur in the gas retained in the deposit was as high as 8%, compared with figures of 0.5 to 1.0% for the first periods for the heaters burning 17 and 3 gr. gas.

The fact that with gas of 0.1 gr. sulphur the corrosion is greater than with gas of 3 gr. sulphur content agrees with the laboratory results of Wood[5], and it suggests that there may be no advantage, from the point of view of corrosion of appliances of the type under consideration, in reducing the sulphur content of town gas much below 3 gr. As the deposit is much harder and more firmly attached to the heater, however, further work is necessary to confirm this.

(b) Effect of Time

The figures in Table 3 show that the total weight of deposit obtained in any period increased as the experiments proceeded. Superficially, it would appear that this increase was most marked between the first and second periods, but the effect is probably exaggerated because at the end of the first period a small amount of corrosion product was unavoidably left on the metal surfaces. Consequently, the weight of deposit collected at the end of this period was less than the amount actually found, while in subsequent periods approximately the same amount of product was left at the end as was present at the start. Even allowing for this, however, it is concluded that the weight of deposit found increases with time, but tends towards a maximum in its value.

(c) Behaviour of Different Appliances

With both the district gas and the low sulphur gas the heaters of Type " A " gave a greater quantity of deposit than did the heaters of Type " B "; this result was more noticeable with the 17 gr. gas. Moreover, the proportion of copper in the deposit from heaters of Type " A " was higher initially than in the case of heaters of Type " B." This is not unexpected in view of the differences in the thickness of coating on the two types of heaters.

Heaters of Type " A " are coated with a mixture of approximately equal proportions by weight of tin and lead, while heaters of Type " B " are coated with a mixture of 4 parts of lead to 1 of tin. These differences are reflected in the corrosion deposits: the initial deposits from heaters of Type " A " had a low lead content, but by Period 4 the ratio of lead: tin was approximately 1: 1 in the experiment using the 17 gr. gas, and was tending towards it in the experiment using the 3 gr. gas. Heaters of Type " B " also gave deposits whose ratios of lead: tin increased with time.

(d) Effect of Thermal Input

It is believed by certain gas undertakings that less corrosion is experienced if an appliance be operated a little (say 10%) below its rated throughput. It was for this reason that two of the Type " B " heaters, B_2 and B_4, were operated at a lower input. Since the gas was turned off and on at the same intervals of time, there was a reduction in the amount of oxides of sulphur produced in the appliance, but not in the number of heating operations. The results obtained, given in Table 3, show that heater B_2 at the lower rating corroded slightly more than heater B_1 operating at the rated output, in the case of the 17 gr. gas. It may well be that the reduced quantity of oxides of sulphur available for corrosion was counterbalanced by the fact that with a lower input of gas, rise in temperature was slower, and consequently there was a longer period during which condensation could take place.

In the case of the 3 gr. gas it will be seen (Table 3) that there was a reduction in the extent of corrosion in heater B_4 at the lower rating when compared with heater B_3 at the normal rating. This was particularly noticeable during Period 1. This result may not be incompatible with that obtained on 17 gr. gas, since the dewpoint of the flue gases is lower when the proportion of sulphur oxides is lower. Another point of difference between the heaters operated at a low thermal input and those operated at the normal input is that with both high and low sulphur gases the former heater gave a corrosion deposit containing appreciably less lead. The significance of this is not clear.

It will be seen that there is no evidence in the present experiments to suggest that there is any advantage from the point of view of corrosion in operating heaters below the rated throughput, at any rate when district gas is used.

(e) Oxides of Nitrogen

It has been shown that when gases of either 17 gr. or 3 gr. sulphur per 100 cu.ft. were used, the nitrate concentration in the deposit was less than 1: 1,000 of the sulphate content. On the other hand, when a gas of 0.1 gr. per 100 cu.ft. was used the ratio of nitrate to sulphate was 2.34: 1. It is clear that in this case oxides of nitrogen from the flue gases were playing a considerable part in the corrosion.

It is possible that some of the corrosion was in all cases caused by oxides of nitrogen, but when the concentration of oxides of sulphur was higher the latter displaced the former from the deposits. This hypothesis can be further extended to account for the greater extent of corrosion when the very low sulphur gas was used, by postulating that a certain degree of protection of the walls is provided by lead sulphate. This protection may be adequate down to that critical sulphur content which is sufficient to form a protective layer in the required time, but below this sulphur content the extent of corrosion may increase owing to uncontrolled nitrate production and attack. Tests on heaters using gases of other sulphur contents, *e.g.*, 5 and 1 gr., are required to substantiate this hypothesis.

In addition to nitrates, it is possible for nitrogen to appear in the deposits as nitrites or as ammonium salts. The only case in which it was possible for the deposit to be tested for nitrite was in the case of that from heater B_5, in which it was most likely to be found. No nitrite could, however, be detected.

The ammonium concentration in the deposits was of the order of 0.05% or less in all cases (Table 5). Although the amount is small it may be of significance in connexion with the mechanism by which the corrosion occurs. Tests on the laboratory air showed that there was insufficient ammonia present to account for the ammonia in the deposit. A possible explanation is that the ammonia was produced by reduction of nitrates at the heater surface when the tin was acted upon by dilute acid. It is significant that the ammonium concentration was greatest in the deposit from Type " A " heaters in which the protective coating had the higher concentration of tin.

Conclusions

The main conclusions from the experimental work are as follows:

(1) A reduction in the sulphur content of town gas from 17 to 3 gr. per 100 cu.ft. reduces the corrosion of water heaters nearly proportionately.
(2) There is probably a limiting value for the sulphur content below which corrosion begins to increase again. This is in agreement with the laboratory tests of J. W. Wood. The limiting value may lie in the neighbourhhod of 3 gr. per 100 cu.ft.
(3) Oxides of nitrogen may play an important part in the mechanism of corrosion, particularly with gases with sulphur contents below this limiting value.
(4) There is less corrosion in heaters with a moderately thick coating of solder of high lead content than in heaters with a thinner coating of higher tin content.
(5) The rate of formation of corrosion deposits increases with time, but probably reaches a limiting value.
(6) A 10% reduction in the thermal input did not result in less corrosion except in the case of gas containing 3 gr. of sulphur per 100 cu.ft.

The Authors' thanks are due to Dr. E. V. Evans (General Manager, South Metropolitan Gas Company) for granting facilities for this

[5] *Trans. Inst. Gas Eng.*, 1936-37, **86**, 58.

* From Publication 27 of the Gas Research Board.

work; and to Mr. H. Stanier (Chief Chemist) and his staff for the assistance placed at their disposal. The Authors also wish to acknowledge the facilities afforded by the Director of Fuel Research for the experiments with gas of very low sulphur content; and they wish to thank Mr. J. J. Guy, of the Gas Research Board, for conducting these experiments.

Appendix 1.—Method of Determining the Total Sulphur Content of Gas

Approximately 0.5 cu.ft. per hour of the gas to be tested is metered and burnt at an inverted pyrex glass jet, the air for combustion being drawn by a water pump through a tube concentric with the jet. The products of combustion pass down a pyrex glass water-cooled condenser and the condensate is collected in a flask. The gaseous products are washed free from sulphur oxides by bubbling through N/5 caustic soda solution contained in two Dreschel bottles in series.

Approximately 75 ml. of caustic soda solution is used in all, about one-third of this being in the flask, and one-third in each of the Dreschel bottles. After the test has terminated, the contents of the flask and washers are rinsed out into a large beaker and evaporated with an excess of hydrochloric acid to a bulk of approximately 50 ml., to displace any carbon dioxide present. The solution is then neutralized with dilute caustic soda, using phenolphthalein as the indicator, and the volume made up to 100 ml. in a graduated flask.

The sulphur content is determined by titrating 25 ml. portions of the solution plus an equal volume of isopropyl alcohol with N/20 or N/40 barium chloride solution using T.H.Q. as an indicator, as recommended by Sheen and Kahler[9].

The concentration of sulphur in the gas is calculated from the volume of gas burnt and the weight of sulphur found in the determination.

Appendix 2.—Methods of Analysis of Deposits

(i) *Metals*

The method used was similar to that usually employed in the analysis of a bronze alloy, although the presence of lead sulphate and traces of silica made the separation of the metals more tedious.

Approximately 1 g. of finely powdered deposit is evaporated to dryness with concentrated nitric acid, to disintegrate any small particles of solder present, and to convert the tin to an insoluble form of stannic oxide. The dry residue is warmed with dilute nitric acid to dissolve the nitrates and the whole filtered whilst hot. The precipitate and filter are ignited at 700° C. and weighed, while the filtrate containing the copper and the major portion of the lead is set aside.

The ignited precipitate, which may contain stannic oxide, lead sulphate and traces of silica and iron, is washed with hot ammonium acetate solution, re-ignited in the same crucible and re-weighed. The lead in the washing solution is determined as lead chromate.

To determine the stannic oxide in the residue, the contents of the crucible are thoroughly mixed with ammonium iodide, and the stannic oxide volatized at 500° C. as stannic iodide, the process being repeated till no further loss in weight occurs. The residue, which is a dark brown powder, is mainly silica and iron.

To the filtrate from the original stannic oxide precipitation is added 3 ml. of concentrated sulphuric acid, and the solution is evaporated until dense white fumes are evolved. The solution is then diluted to 100 ml., and the lead is determined as lead sulphate. The weight of lead found here is added to the weight previously found in the stannic oxide precipitate.

The copper is estimated by an iodimetric method employing the modification recommended by Foote and Vance[10] in which the interference of ferric iron is avoided by formation of a complex fluoride.

(ii) *Sulphate*

Concentrated sodium carbonate solution is stirred with 0.2 g. of the deposit on a steam bath in order to extract the sulphate as sodium sulphate, and to precipitate the metallic constituents as basic carbonates. The latter precipitate is filtered from the solution, and after ignition and re-powdering is further extracted.

To the filtrate from the two extractions an excess of hydrochloric acid is added, and the carbon dioxide is displaced by boiling. The solution is then made neutral to phenolphthalein and the sulphate is estimated volumetrically by titration with barium chloride solution, using T.H.Q. as an indicator as recommended by Sheen and Kahler.[9]

(iii) *Water*

The water content of the deposit is determined directly by passing a stream of dry air over a mixture of known weight of the deposit with an excess of lead chromate, the whole being heated to 300° C. The water evolved is collected in weighed calcium chloride tubes.

(iv) *Ammonia and Nitrates*

A dilute caustic potash solution is distilled until the distillate is free from ammonia; it is cooled, a known weight of corrosion product is added, and further samples of the distillate are collected. The ammonia in the distillate is estimated colorimetrically with Nessler's reagent.

The nitrate concentration is found by adding Devarda's alloy to the solution left after the ammonia distillation, and boiling gently for 3 hours so that re-fluxing occurs on the sides of the flask. The rate of boiling is then increased, and successive 50 ml. samples are distilled over and the ammonia content estimated as before. Assuming that this ammonia has been produced by the reduction of the nitrates present, the concentration of N_2O_5 in the product can be calculated.

[9] *Ind. Eng. Chem.*, Anal. Ed. 8, 1936, 127.

[10] *Ind. Eng. Chem.*, Anal. Ed. 8, 1936, 119.

Appendix 3.—Examination of the Coatings of Instantaneous Water Heaters

By J. P. Welsh, B.Sc., A.R.I.C. (The Gas Research Board)

In order that any differences in the rates of corrosion of the two types of water heater should, if possible, be related to the method of construction and the type of coating, and to obtain information as to the manner in which the corrosion occurred, a microscopical examination of the new heaters and of those used in the corrosion experiments was carried out.

The Examination of Heaters before Use

As indicated in the main Report, the two types of heaters under examination were of the same general design, though with a number of minor differences; both were constructed from copper sheet. Apart from the fact that in Type " B " the fins were brazed to the central and outer walls of the combustion chamber, all the joints were made with soft solder, and the sheeting was covered with solder to protect it from the products of combustion. The composition of the solders used in the construction of these heaters is given on page 9 of the main Report.

Visual examination of an unused heater of Type " A " (reference A_{10}) showed that the copper surfaces had been well covered with solder applied by wiping, and that the coating throughout the heater was very even. This heater contained one set of fins, Z, tacked with soft solder to the central chamber of the heater and soldered to the main body, X. The shield, Y, was soldered to X at two levels, but was not completely held along its top edge; this appeared to be a weakness, as corrosion products could work down between Y and X. The inside surfaces of the heater were quite clean, and no flux residues were present.

The general appearance of the unused heater of Type " B " (reference B_{10}) was somewhat marred by the unevenness of the coating of solder on the shield Y. There were two sets of fins in this heater, one above the other, and the shield was securely fastened to the wall of the water-jacket, both at the top and at a lower level. All the surfaces, with the exception of the outside wall, had been coated by dipping. On the outside wall the solder had been electro-deposited.

Thickness of the Protective Coating

While the average thickness of solder coating over an area of the surface could be determined by weighing the specimen before and after removing the coating by chemical means, a method capable of giving the variation in thickness from place to place on the surface was required. The method adopted was to measure the coating thickness directly under a microscope, using a specially prepared specimen. An additional advantage of this method was that the sections, once prepared, could also be used for determining the state of the solder coating in relation to the copper base.

Sections 2 in. wide were cut from the tops to the bottoms of the heaters, at a distance midway between the inlet and outlet pipes. from these sections strips were cut from parts X, Y and Z. These strips were so thin that they could not be held firmly during the polishing operations. Attempts were made to mount them directly in white metals and in sealing wax, but neither of these methods proved successful on account of the smearing of the solder during the polishing operations.

The technique finally adopted was as follows: In order that they could be fitted into a mould, the specimens were bent over a small radius, de-greased in carbon tetrachloride, and then copper-plated to a thickness of 2 to 3 thousandths of an inch. They were then mounted in a thermo-plastic mounting medium called " Diakon," which was particularly suitable for the work since it was transparent and allowed a full view of the mounted specimens, thus ensuring perfect mounting.

The mounted specimens were put into a close-fitting brass collar, and clamped in a bench vice, with the test surfaces upwards. A smooth file was slowly drawn over the surfaces of the specimens until the cross-sections were completely flat. Oakey's metallurgical quality emery paper of grades 0, 2/0, 3/0 and 4/0 were used for preliminary polishing. The emery papers were well lubricated with paraffin, and only light pressure was used on the specimens. It was found necessary to use meticulous care in washing the specimens, polishing discs and even the operators' hands between the different operations, to prevent larger-sized abrasive particles getting through to the next operation and spoiling the work already done. This precaution was most necessary in the final polishing operations.

The earlier specimens were polished by hand on selvyt cloth moistened with a paste of magnesium oxide and water, followed by polishing

on selvyt moistened with "Silvo" metal polish. This was later abandoned in favour of a more rapid method using Microid alumina, which had the advantage that the shape and hardness of the grains were constant and that the depth of the scratch produced in the specimen was uniform. The specimens were then polished on a selvyt cloth stretched on an aluminium disc and impregnated first with a suspension of 5/20-grade alumina, then on a second disc using 4/31-grade, and finally on a third disc using 3/50-grade alumina. Each operation took not longer than 3 to 5 min. to complete.

The polished surfaces were microscopically examined, using reflected light. Photo-micrographs of typical sections of each type of heater are shown in Plates 13 and 14. The solder layer is seen between the base cooper, on the outside, and the electro-plated copper in the centre. The solder thicknesses found on each surface examined were reasonably constant, and the average values for the various surfaces in thousandths of an inch are shown in the following table:

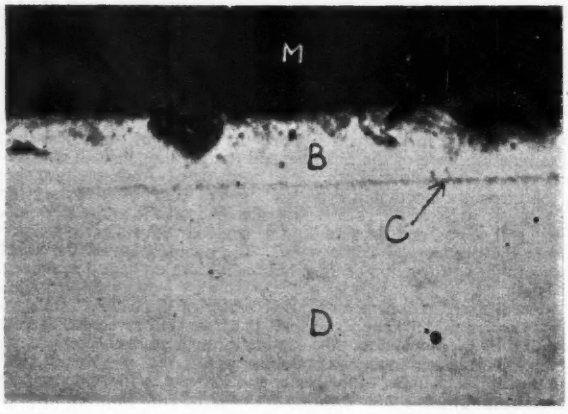

PLATE 13.—*Section showing Average Thickness of Solder Coating in New Heater, A_{10}.* (× 100.)
M = *Diakon mountant* B = *Copper plating*
C = *Solder layer* D = *Base copper*

Coating Thicknesses in Thousandths of an Inch

Heater	Surface	Position: Inside	Position: Outside
A^{10}	X	0.10	0.12*
	Y	0.10	0.10
	Z	0.18	0.16
B^{10}	X	0.90	1.70*
	Y	2.40	1.90
	Z	0.70	1.10

* These surfaces are on the water side.

Structure of the Protective Coating

The specimens used for the determination of the coating thickness were examined for evidence of the solder alloying with the copper. There was, however, no alloy layer observable in any of the specimens,

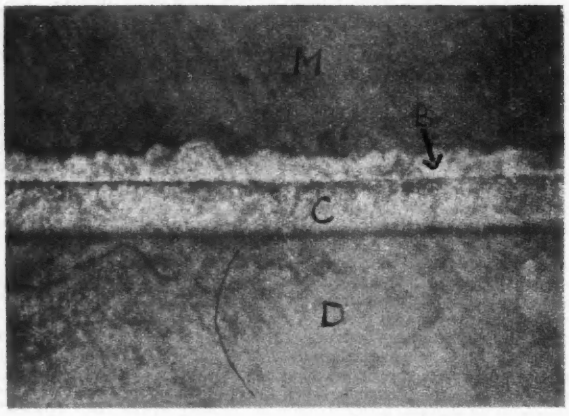

PLATE 14.—*Section showing Average Thickness of Solder Coating in New Heater, B_{10}.* (× 100.)
M = *Diakon mountant* B = *Copper plating*
C = *Solder layer (unalloyed)* D = *Base copper*

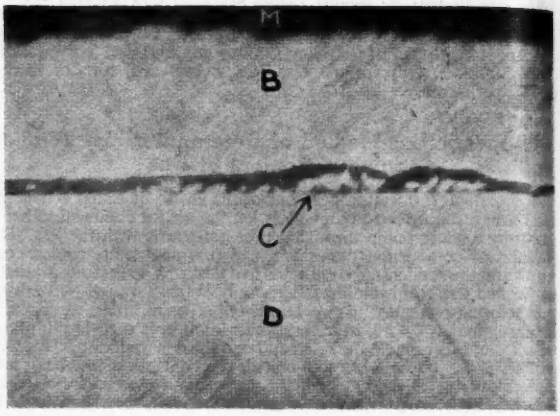

PLATE 15.—*Section showing Alloying in Heater A_1.* (× 100.)
M = *Diakon mountant* B = *Copper plating*
C = *Solder layer with alloy showing white* D = *Base copper*

in either the unetched or the etched state. The boundary between the solder layer and the copper layer was quite distinct, and there was no intermetallic compound apparent between them. This is shown in Plates 13 and 14.

In the specimens examined under the microscope the coatings in A_{10}, although apparently uniform and complete, were very thin, and it was felt that these layers might be porous or pinholed. Since there was no alloying of the solder with the copper base the completeness of the solder coating could be judged by the presence of copper in the surface layer. On this basis the following methods were used for the determination of the completeness of the coatings:

(*a*) The cut edges of the clean, grease-free specimens were protected by dipping them in molten paraffin wax. The specimens

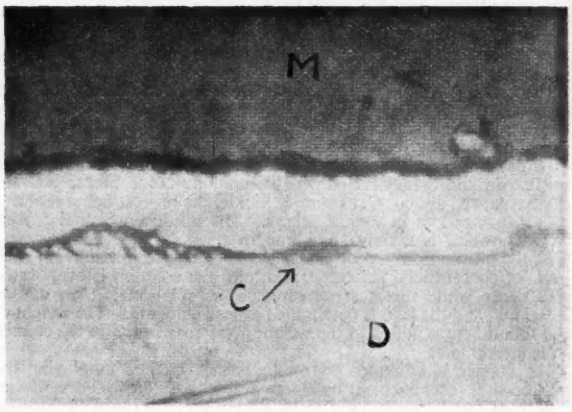

PLATE 16.—*Section showing Building-up of Solder and Alloy to form Pimples in Heater A_1.* (× 100.)
M = *Diakon mountant* D = *Base copper*
C = *Solder and alloy layer showing building-up into pimples*

were then immersed in a 10% solution of ammonium persulphate containing 75 ml. of 0.88 ammonia per litre. This solution rapidly attacks copper, producing an intense blue-coloured solution. After immersing the specimens for 15 minutes, the solutions were all colourless, showing that there was no exposed copper and no breaks in the solder coating.

(*b*) The ammonium persulphate method suffered from the disadvantage that the heater had to be sectioned in order to apply the test. In the second method the reagent used was a 0.1% solution of agar-agar to which 5 ml. acetic acid and 1 ml. 0.1% rubeanic acid were added. The warm gel was poured over freshly cut and protected specimens and allowed to set. Any exposed copper would be attacked and the characteristic black-green precipitate of the copper-rubeanic acid complex formed. The object of the gelatine was to localize the complex and thus indicate the extent of free copper exposed. The gel when set covered the specimens to a depth of about 3 mm., and, in order to examine for copper, this was peeled off, after being left in contact for 15 minutes, on to a filter paper for colour observation. There were no green colorations of the gel

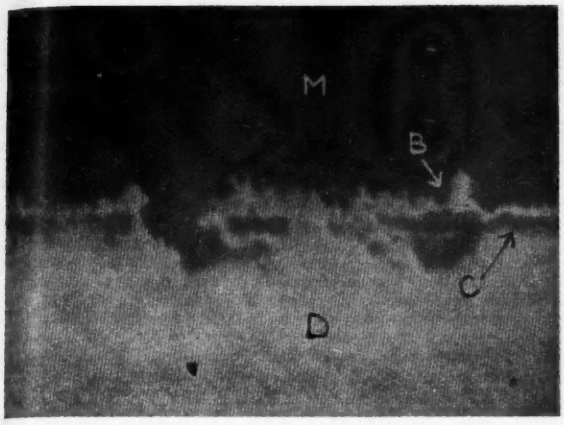

PLATE 17.—*Section showing Penetration of Base Copper in Heater A_1.* (× 100.)
M = *Diakon mountant* B = *Copper plating*
C = *Solder broken-up* D = *Base copper*

with any of the specimens, and the coatings were consequently considered to be complete and free from porosity and pinholes.

(c) The third method used is mentioned in the literature (*Chimie et Industrie*, 1929, **21** (2), 425, and 1930, **22** (3), 247) under the title of "Electrographic Analysis." The surface under test is made the anode of a cell where the electrolyte is, *e.g.*, filter paper impregnated with a suitable electrolyte. The cathode is a conductor roughly of the same contour as the anode. When a current flows across this cell the top layer of the specimen is lifted off and transferred to the absorbent paper, where identification tests can be carried out. The particular advantage of this method is that the top layer may be examined without interference from the base metal.

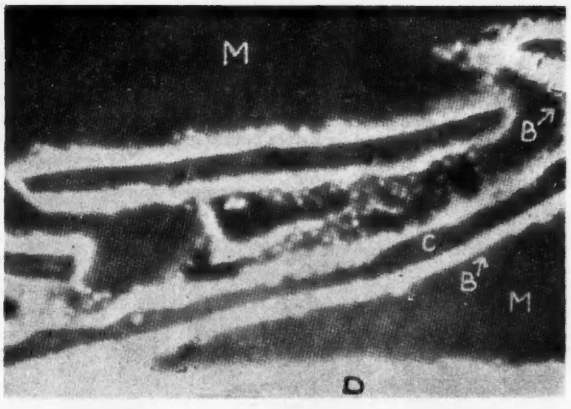

PLATE 18.—*Section showing Lifting of Solder Coating from Heater B_1 This coating is copper-plated on both sides.* (× 100.)
M = *Diakon mountant* B = *Copper plating*
C = *Solder layer* D = *Base copper*

The surfaces of the heaters A_{10} and B_{10} were examined by the method, using four thicknesses of "Whatman" drop-reaction paper impregnated with 5% solution of sodium nitrate as the electrolyte, and aluminium foil as the cathode. The current was supplied by six 2 v. accumulators, and was applied for a 10 second period to each specimen in turn. The cathode was lightly pressed against the pad of moist filter paper, and the current switched on until about 50 micro-coulombs per sq. cm. of the surface had passed across the cell. The paper was then removed and placed on a sheet of dry filter paper. Another sheet of filter paper, impregnated with rubeanic acid solution, was pressed on to the surface which had been in contact with the heater surface. All of the surfaces tested gave negative reactions for copper, showing that there is no copper in the surface layer, and, therefore, that the coating of solder protecting the copper was complete.

The use of all three methods led to the same conclusion, that in new heaters the whole of the protective coating was continuous and showed neither porosity nor pinholes. It is considered that the electrographic analysis method could be developed further to yield a very useful method of test to be applied to the visible surfaces of heaters before they were put into service.

The Examination of Used Heaters

The six heaters (A_1, A_2, B_1, B_2, B_3 and B_4) used in the corrosion experiments were examined for completeness, thickness and metallurgical condition of the coating. A general examination was carried out on a 4 in. section of each heater, and then a separate 2 in. section was examined microscopically.

A_1 and A_2

In both cases some of the solder coating had been removed from the shield, Y. In A_1 the top three-quarters were almost bare; in A_2 the top one-third was bare. The rest of the coating had been corroded, but in each case there was still unchanged solder. The fins in A_1 had been attacked for the upper two-thirds of their length, and were covered with a residue of the corrosion product removed for analysis. The fins in A_2 showed no bare copper, but were covered with a white deposit for one-third of their length. Penetration of corrosion behind the top of the baffle had only occurred in the case of heater A_1.

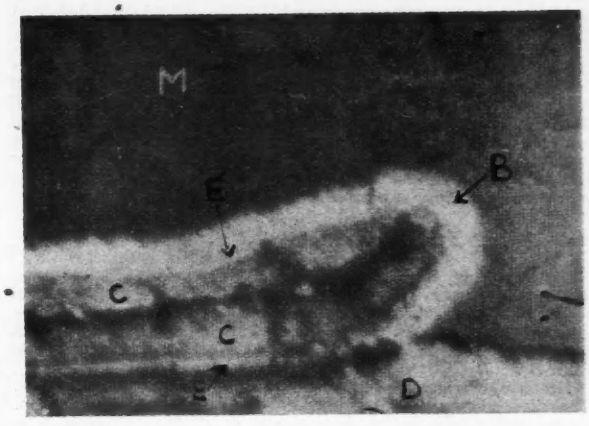

PLATE 19.—*Section showing Peeling of Solder Coating from Heater B_2.* (× 100.)
M = *Diakon mountant* B = *Copper plating*
C = *Solder layer* D = *Base copper*
E = *Alloy layer* *A* = *Air gap*

Microscopical examination of sections showed that the X surfaces in both heaters retained a thin solder layer, although most of this had alloyed with the base copper. This alloy is clearly shown in Plate 15. There was distortion of the solder layer on the gas side in both heaters, and formation of solder globules was suggested by the presence of pimples (Plate 16). On the shields the alloying was almost complete. Large gaps were to be seen in both heaters where the solder and alloy

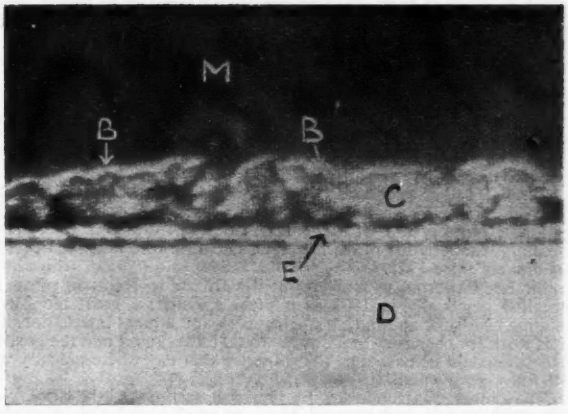

PLATE 20.—*Section showing Condition of Solder Layer in Heater B_4.* (× 100.)
M = *Diakon mountant* B = *Copper plating*
C = *Solder layer* D = *Base copper*
E = *Alloy layer*

had been removed from the copper surface. The corrosion on the fin area seemed to be of the same order in both heaters. It was evident that more corrosion had occurred in A_1 burning 17 gr. gas than in A_2 burning 3 gr. gas. In both heaters some penetration into the base copper was shown in the fins (Plate 17).

B_1 and B_3

The results of corrosion were seen in bare copper patches on the fins and on the central walls of the heaters. In B_1 corrosion had penetrated about ¼ in. downwards between the top of the shield, Y, and the water compartment, X; and the baffle showed two large areas of copper which were free from solder above the flame level. In contrast to this, the shield in B_3 was still completely coated with solder, although there were on the surface a large number of small pimples of deposit which might serve as nuclei for further corrosive action. The solder coating behind the baffle in both cases had been attacked and was only lightly adherent to the copper surface, Y.

Microscopical examination showed that the coating had lifted from the side of the shield in B_1 and that there had been heavy local corrosion of the base copper where the protective layer had disappeared. Both the solder and alloy layers were visible in these specimens, and in places both sides of the layer had been copper-plated (Plate 18). The shield in B_3 showed some breaks in the coating, and a small amount of corrosion of the base copper. The solder which had partially alloyed with the base copper was still adhering to the base. The fins in both sections showed fairly heavy corrosion, with the solder alloy missing or lifted away from the base copper. In all surfaces examined there was a much larger expanse of corrosion in B_1 and in B_3.

B_2 and B_4

General examination showed that in B_2 the extent of the corrosion was similar to that in B_1. There were large areas, on the fins, the central walls and on both sides of the baffle, where the solder coating had been attacked and had been removed. The amount of coating removed from B_2 appeared to be greater than that from B_3 and less than that from B_1.

Heater B_4 was in much better condition than any of the other heaters. The solder coating was adhering everywhere except on the bottom ½ in. of the central chamber of the heater, where some had peeled off, although there was no exposed copper. There was a coating of corrosion product on the lower parts of the fins, but this was strongly adherent, and when it was removed the surface appeared to be fairly complete.

Microscopical examination showed that in B_2 some of the solder coating on both sides of the shield was peeling (Plate 19), whereas in B_4, although there were a few breaks, most of the coating was of a good thickness and intact (Plate 20). The fins in both heaters showed alloy formation between part of the solder and the copper. The coating had partially melted and had started to run into globules.

On the shields of all the Type " B " heaters there was, just below the area of corrosion, an area with a much thicker layer of solder which showed no corrosion. It would seem that the solder in the unalloyed form was resistant to active corrosion by the products of combustion. Unfortunately, at the working temperature the coating slowly softened and then moved downwards, draining off the fins and shields. The alloy left in contact with the copper did not seem to offer the same resistance to corrosion as the unalloyed coating. The solder layer behind the shields seemed to corrode and then peel from the surface of the copper.

Conclusions

(1) In general, the microscopical and analytical examination of metal sections cut from unused and used water heaters leads to the same conclusions regarding corrosion effects as have been drawn from a study of the weights and compositions of corrosion products.

(2) In unused heaters the protective coating is not alloyed with the copper walls, &c, and the layers for each heater wall are uniform in thickness and show neither porosity nor pinholes.

(3) Thinning of the protective coating takes place, with drainage forming globules, and bare patches developing particularly on the main walls and shields. Deposits of corrosion products are particularly marked on the fins, and are accompanied by deterioration of the coating.

(4) The coating remaining is alloyed with the copper walls, and this alloy is apparently less resistant to attack than is the original coating.

Ramsay Chemical Dinner

The Gas Industry joined with the chemical, plastic and rubber industries to revive the Ramsay Chemical Dinner at Glasgow on Dec. 6 after a lapse of seven years. Founded in 1922 to the memory of Sir William Ramsay, the famous chemist who pioneered the co-ordination of academic and industrial chemistry, the dinner is perhaps the only event of its kind which unites in one function all the chemical industry organizations.

Speaking as Chairman Sir Steven Bilsland indicated that the Scottish Council (Development and Industry) had completed a survey of the chemical industries in Scotland which would give useful direction to further development and which would be published in the spring.

Sir Jack Drummond proposed the toast of " The Profession of Chemistry " and claimed that never before had chemists faced the future with so much confidence and enthusiasm, nor had the status of the chemists been so high in the community. He welcomed the increased financial and other aid now being given to the universities and looked forward to their taking a leading part in maintaining the teaching of chemistry. He had recently returned from Africa, where he found promise of immense development and opportunity for the chemist in the next 50 years.

The Mainspring of Industrial Activity

Dr. L. H. Lampitt, who replied, said that the chemist, perhaps more than any other professional man, held the major say in the revival of industrial and national life and chemists were now the main-spring of industrial activity.

Mr. H. Talbot proposed " The City of Glasgow," and Sir Hector McNeill, Lord Provost, replied.

Dr. Cranston (Royal Technical College) proposed the guests, recalling the long list of distinguished chemists who had been present at dinners since 1922.

Sir Ian Heilbron, in replying, paid a tribute to Ramsay, whom he recalled personally in 1909 as a great scientist, a great pioneer in uniting academic and industrial chemistry and a great internationalist. His work for chemistry in industry would have caused him the greatest pleasure could he have seen the gathering that day where industry was so fully represented.

The dinner was supported by the local sections of the Society of Chemical Industry, the Royal Institute of Chemistry, the Chemical Society, the Alchemists Club, the Andersonian Chemical Society, the Ardeer Chemical Club, the British Association of Chemists, the Institute of Petroleum, the Oil and Colour Chemists Association, the Institution of the Rubber Industry, the Institution of Plastics Industry, and the Institute of Fuel.

The Courtesy Campaign

A few weeks ago the Mayor of Hendon asked Hendon's schools to co-operate in a courtesy campaign. The children of various schools were asked to design posters with " courtesy " as the keynote, and when the posters were collected they were put up in the Hendon Town Hall in an exhibition.

The Display of posters at the Golders Green Showrooms.

The Gas Light and Coke Company were invited to see the pictures and thought they were so good that some of them would merit a special display in their Golders Green Showrooms. This special display was put in these showrooms on Nov. 29, when the exhibition was opened officially by the Mayor of Hendon, and from the first day it has excited a good deal of public interest. The posters and drawings selected are full of ideas and are extremely colourful; indeed, some of them are really good examples of artwork.

This special display will remain in the showrooms for a few weeks.

Constructive Criticism on Research

A Discussion following Presentation of the Annual Report of the Gas Research Board Last month

Mr. J. T. Haynes (Engineer and Manager, Bournemouth Gas & Water Company), said he had been dubbed a "practical" man, so he hoped he would be forgiven if, at a research meeting, he emulated the proverbial bull in the china shop. He continued:

Early in its life the Gas Research Board realized the necessity of dividing its programme into three groups:—

(a) Research—
into future possibilities in connexion with the utilization of solid and gaseous fuels.

(b) Long range investigation—
into methods of improving present practice, and

(c) immediate solution of the more complex technical problems of general interest to the Industry.

Viewpoint of the Practical Man

The 7th Annual Report gives an able resumé of the progress made in each of the three groups, and the Board and its Officers are to be congratulated on the fund of information now made available. So far, however, the practical man—practical as distinct from the purely scientific—can find little that he can lay hold on as a result of seven years' research. May be it is true that research never reaches finality, each problem inevitably leading to several others, but the so-called practical man does look for some positive solution to his problem, for that solution to be couched in words of one syllable and for simple advice on how to put the findings of the research worker into every-day practice.

Because of Bournemouth's close association with the Gas Research Board, I see more of their work than many of the members, but we should like to know when we are going to get a direct lead on the complete cycle of coal carbonization. Are we still waiting for the Lurgi generator, and what is the position of the proposal to preheat the air to water gas generators to improve their efficiency?

A Complete Team

The complete team from the practical man's point of view would appear to be:—

(1) The research chemist to provide a theoretical solution to a problem.

(2) The chemical engineer to translate that theory into practice by designing the necessary plant, and

(3) The engineer to construct and operate the plant so that it may be economically successful.

Such a team could deal with another of the major problems of the Gas Industry—that of purification. For over 100 years the accepted method has been to extract H_2S from the gas by sulphiding hydrated iron oxide in expensive cumbersome purifying boxes, then to re-oxidize the sulphide of iron by exposure to the atmosphere. When after the cycle has been repeated the resultant mass of material contains about 50 per cent. of free sulphur it is transported to another part of the country where the sulphur is extracted, or burnt, and converted into sulphuric acid in more expensive and cumbersome plant. That acid is then transported back to the gas-works to be mixed with ammonia from the gas to form a fertilizing material in still more expensive plant. And the net result to the Gas Industry is a minimum cost of gas purification—rarely any profit. Can we not improve on this?

Why Not Liquid Purification?

The new method of liquid purification now being tried out at Manchester does not solve the problem. In effect, it only "super-hydrates" the oxide, thus enabling the gas cleaning part of the series of operations to be carried out in cheaper and less cumbersome plant and with less labour. It is meeting with considerable success, but the major problem remains.

Curiously enough the perfect answer was almost in our hands 20 years ago. In the Burkheiser process the crude gas was passed through one of a twin pair of vessels containing nodules of iron oxide. When these were sulphided the gas was turned into the other vessel and air burnt the sulphur in the sulphided material to SO_2 restoring the nodules to the active oxide condition. The SO_2 was dissolved in water through which the incoming gas containing its ammonia was bubbled forming ammonium sulphite crystals which were collected at the base of the saturator. On exposure to the air part of the sulphite was converted to sulphate. Thus, in one simple cheap and very compact plant there was obtained direct from the gas, with practically no labour, a particularly high grade fertilizer. Can any scientist or gas engineer ask for anything more desirable?

And the process as tried out at Bournemouth on a 2 million cu.ft. per day plant only broke down finally on one factor and that a purely physical one—the iron oxide nodules disintegrated under the repeated changes of temperature. The original nodules were pieces of natural iron ore from a Silesian source and apparently had some peculiar structure, for, so far as is known in this country, further supplies could not be obtained. Except for this physical factor the process worked perfectly and ammonium sulphate and sulphite were actually produced quite readily and the gas was entirely freed from H_2S and ammonia.

Is not this a "nut worth cracking"—to find a method of producing nodules of active iron oxide which will stand up to repeated violent changes of temperature without disintegrating?

I throw it out as a challenge to the Research Board.

Immediate Problems

Mr. **T. C. Battersby** (Engineer and Manager, Watford and St. Albans Gas Company):—I am sure it is generally agreed that our research workers should explore new gasification processes but the development of new methods is a long term policy. We could not be criticized if we deduce from the trend of experimental work that it is only by the adoption of high pressure processes that we can achieve any appreciable increase in conversion efficiency. It would be helpful at this stage to have from the Board an indication of the overall thermal efficiencies of these new methods. Could these figures be made available? The thermal efficiency of gas-works is a subject prominently before us these days. I would suggest that while the Board is undoubtedly justified in pursuing the hydrogenation of coal, the existing processes of gas production should receive greater attention and a careful balance should be preserved between our efforts to develop a new technique and the improvement of existing practices.

If we can develop and adapt our present plants to process a wider range of coals, we might reach the goal of a one-fuel Industry.

I appreciate that the Board has a much broader programme than is covered by the activities described in the Report, but may I mention some of the immediate problems which are concerning those responsible for the expansion of manufacturing plant and the development of the industrial load on which we require information and guidance:

Take the design of retort settings to overcome the difficulties due to the expansion of refractory materials. This seems a matter on which individual contractors have divergent views, but surely it is a matter on which the Research Board should be able to give authoritative guidance.

The recovery and utilization of heat in hot coke. During the last 20 years very little progress has been made and we cannot be satisfied with the present position.

Having regard to the necessity to reduce manual labour, does the higher thermal efficiency of mechanical producers justify the heavier capital outlay incurred by this design?

With the trend towards the centralization of gas manufacture, the disposal of effluent liquor from ammonia plants will become increasingly acute and instead of spent liquor flows amounting to ½% or even ¼% of the sewage flow, volumes considerably in excess of these figures will have to be handled. In this connexion it is probable that ammonium thiocyanate is the most objectionable constituent with which we have to cope, and it is pleasing to note that this is receiving the attention of the Board. The results given in the Report are interesting, but is it not likely that the long contact between the liquor and iron throughout the purification plant is responsible for the production of thiocyanate. To-day many works are equipped with washer containing wood boards or brush fillings. Is there any evidence that under these conditions thiocyanate has been reduced to negligible proportions ?

It would also be interesting to know how far ammonium thiocyanate is responsible for the internal corrosion of gas works plants.

Organic Sulphur Removal

I think that many will be disappointed to discover that at the present time the Board does not appear to be giving any attention to the problem of hydrogen sulphide purification. Regarding the removal of organic sulphur I would say that extraction down to 6-10 grains per 100 cu. ft. is not good enough. We must go all the way in this matter and bring the sulphur content of the gas down to the lowest practical limit of any available process. (It would be useful to have a statement setting out the progress made since the Carpenter Evans process was described to the Institution in 1913).

In 1937 we decided in our Company to adopt straightforward oil washing to extract benzole and some sulphur and hoped at a later date to install catalytic sulphur removal plants. It would appear from the Report that this was the correct course to pursue, but has not the time arrived to transfer attention from laboratory investigations to a study of the practical difficulties which now seem the major obstacles to success?

The industrial utilization of gas has brought many problems. The extended use of gas for the smelting of aluminium and its alloys will be jeopardized unless we can overcome the microscopic " pin holing " of the finished castings. Has this metal a peculiar affinity for hydrogen or other constituents of gas? This may be a field for the application of tubular radiant heating.

In the printing industries the fast drying of printed paper and illustrated journals is closely bound up with the sintering properties of the inks and quality of the paper used. The potential demands in this field are considerable and no alternative fuel has so far satisfied the requirements of the trade.

Is Research Properly Balanced ?

I know the Research Board regards the principle of collaborative work with industry as fundamental, but have we an adequate and balanced research team? You will recall that Dr. Lander referred to this matter last year and I hope Dr. King will forgive me if I raise it again. I know he is supported by an excellent and enthusiastic staff, but I think that the team might be strengthened by the inclusion of one or two engineers with wide practical experience.

I hope soon we shall have our own Research Headquarters. Lack of such accommodation must be a serious handicap and must complicate the staffing problem.

Nobody would suggest that the amount of money expended determines the value of research, but it certainly cannot be pursued without adequate financial support. The Report of the Parliamentary and Scientific Committee states that the electrical industry spends at least £1,000,000 per year on research, exclusive of expenditure on radio and telecommunications.

The Gas Industry has a capital of £165 millions and its prosperity depends upon the success of our efforts to raise the overall efficiency and to evolve new methods of production and utilization. In Dr. King we have a Director in whom we have every confidence. Let us see that he has adequate financial resources and personnel proportionate to our responsibilities. We cannot afford *not* to expend more money on research, but I would like to see more emphasis placed on the solution of some of the problems which will be the direct concern of the Industry until new methods of gas production have been developed to full scale and we are able to determine the capital and operating costs.

What is Coal ?

Dr. A. Parker (Director, Fuel Research Board): We do not know what coal is. Research on the constitution of coal has been going on for 50 years but we cannot say very much about it—and that is very long range research. On the hydrogenation side, we want to come down to simple compounds, and we, in our programme, have changed over from our earlier work on hydrogenation of coal and tar, which we feel has been well catered for by other organizations such as the I.C.I. We feel it is more our job to go on to the hydrogenation compounds themselves such as naphthalene and other compounds and get at the fundamental side of the problem.

I have no doubt that Dr. King's difficulty is, first of all, finding facilities and recruiting staff in these very difficult times. Also, maybe, he is having difficulties on the financial side. This work costs money and takes a long time. This type of research involves many problems of great practical importance which could well be tackled, but there is a bigger affiliated problem. We hear a great deal about complete gasification. That is, presumably, the goal, though I am not sure it may not be the goal in 50 years' time.

A Two-Fuel Industry

From my own consideration of the whole question of the use of coal in this country, both industrially and domestically, I have come to the conclusion myself—and I may be wrong—that the goal of the Gas Industry is that it should be, primarily, a two-fuel industry, gas and smokeless solid fuel. Solid fuel has the advantage that it can be stored very easily for peak loads in the winter for both domestic and industrial uses, and with better and more efficient appliances one could have a steady load for solid fuel and a steady load for gaseous fuel. When I say a steady load for solid fuel, I mean that you can use it in the winter, and use gas throughout the year. The Gas Industry should aim at getting not only gas, but solid fuel of high quality. I know that many undertakings are doing that now; the system has been developed for some years and I think it is in that direction that the immediate development—for the next 20 or 30 years—should take place. But this does not mean that I advocate for one moment the neglect of research into complete gasification.

I sympathize with Dr. King. The problem at the present time is not a shortage of problems but what we can tackle now with the facilities available and the staff that could be obtained. It is difficult to get research staff of the calibre desirable. It is a problem to house them and to get equipment.

There is a good deal more than that in dealing with domestic appliances. Nobody has found a method of getting a complete heat balance for the domestic appliance, including convection, and this plays an important part in a composite heat balance. At Greenwich we are nearing the completion of the erection of a building which consists of four rooms which we call calorimeter rooms and we shall endeavour to calculate the total heat produced in each room.

I urge the Gas Research Board in the next few years to get things organized. Admittedly it will be under troublesome conditions, but everybody is talking research. Everybody is saying " Let us spend a million on this or two millions on that " but nobody seems to consider where the men are coming from. Of all the people trained to a Degree standard only two or three can be regarded as leaders of research. There are hundreds of trained men who have no originality, no breadth of vision, and no real leadership. That is the problem.

Reduction of Organic Sulphur

Mr. **C. Cooper** (Messrs. W. C. Holmes and Co., Ltd.):—There is mention in the Report of investigation of the corrosion of welded steel gas mains under crude gas conditions. This subject is really in the hands of a sub-Committee of the British Welding Research Association and this is neither the time nor the place to make observations upon it. It has occurred to me, however, that we might now advantageously put forward an interim report of the proceedings of this sub-Committee. I am against any premature publication but in

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this particular case you will realize that there is a large quantity of plant involved and the publication of the information already available might avoid the installation of new plant under conditions where it would suffer from stress corrosion. It seems to me that we might be able to recommend some reasonable working rules which would be of advantage in this connexion. I shall have to consult the sub-Committee in question, but I think they will agree to the publication of what is necessary for this purpose.

Then there is the question of the reduction of organic sulphur compounds to a tolerable limit and reference is made in the Report to the after-purification of the gas.

With all the ingenuity that has been applied to after-purification, the fact remains that this operation is still a nuisance and it will be agreed that working on crude gas may be a short cut to its elimination. It is one, however, that will call for considerable exploration.

A Challenge Accepted

Mr. **E. Crowther** (Engineer and Manager, Newcastle and Gateshead Gas Company):—Dr. King has thrown out a challenge to the practising engineers of the Industry and I should like to reply, to some extent, to that challenge. The Chairman has been almost apologetic about the slow rate of progress displayed in recent years by the Gas Research Board but, of course, recent years have not been conducive to progress with this kind of work. Indeed, when one looks at the absurdly small sum of money being spent by the Gas Research Board year by year, it is surprising that as much has been done as is set out in this 7th Annual Report.

At the same time, I cannot help asking the Gas Research Board whether they are not spreading their efforts over too wide a field. Is not that the reason that progress appears slow? In other words, I think that if the work was concentrated on a smaller number of subjects, we might see some dividends quickly, from the point of view of the practising engineer, who would like to see some dividends. I am not suggesting that the money we invest is not well invested and that the dividends will not come along some day, but I should like to concentrate the investment a little more in the hope of seeing earlier dividends on fewer things. That, however, is a matter of policy which perhaps the Board has carefully considered and upon which they have made their decision. If they have not carefully considered it, then I commend it to their consideration.

I should also like to ask the Board if they have the courage to abandon a line of research not showing a reasonable prospect of profit. I mean that, having made up their minds to take a subject along a certain line, do they continue along that line even if there is a buffer stop at the end of it? Let us have the courage to drop a line of research if it does not show signs of development. I rather think Dr. King has inherited the Bournemouth plant on trial and that it may not be the right way of attacking this process of hydrogenation of coal. The fluid catalyst method might be a better means of attack. I would ask the Board and Dr. King whether they have really considered this. If this method which we are now trying is the wrong method or does not look as if it is the right method, and we can see some alternative which appears more profitable, let us have the courage to drop the current scheme. I appreciate that in a particular line of research it is impossible to say how much money is going to be spent or how much time will be taken up before one reaches any sort of finality, but I do suggest that, having spent a certain sum, the whole position should be reviewed before the next block of money is spent on any particular line of research.

Query

Then what are the major problems before the Industry? I think we should get rid of coke a good deal earlier and I contemplate that we shall not be able to maintain the prices that we are now obtaining for coke of the type and quality which, not entirely through our own fault, we are obliged to sell to-day. I cannot help feeling that the whole economy on which our prices are based is thoroughly artificial, and if the supply of coal becomes plentiful again at a reasonably early date, we are not going to be able to sell coke at the prices we are getting to-day—and then what will happen to our balance sheet?

I welcome the most strenuous effort even to the extent of not providing coke as an alternative to gas. Let us be a one-fuel industry as far as possible. Why Dr. King should be pre-occupied at this time of day with calorific values of the order of 500, when he is seeking to bring about the total gasification of coal, I just do not know. In my opinion, we should be very much wiser to go to far higher calorific values, which would be an advantage to the distribution engineer and the capital investment in distribution and measurement plant.

Finally, there is one other big problem—the problem of the winter peak load. The accountants have told us that this is a bad load and have implied that we should either seek to avoid it or put such a price on it as will make it pay for itself. Cannot the Gas Research Board find some readily condensible hydrocarbon which can be stored with less trouble than methane—something a little higher in the series—and make something of that nature which we can use during the peak load time to supplement our production?

Removal of Organic Sulphur Compounds from Gases*

PREVIOUS Reports have described how, by treatment over a copper-chromium catalyst at 250° C., the organic sulphur content of water gas could be reduced to 0.2 to 0.5 gr. per 100 cu.ft. For the synthesis of methane using a nickel catalyst, however, it is necessary that the sulphur content should be less than 0.002 gr. per 100 cu. ft., and experiments are, therefore, being made to determine the most satisfactory method of achieving this further purification.

One proposed method was to pass the gas through two additional stages of copper-chromium catalyst operating at 250° C., removing the hydrogen sulphide after each stage at the same temperature by a solid reagent. This treatment resulted in a final sulphur content of not more than 0.002 gr. per 100 cu.ft., but it was regarded as too complex to be applied on a larger scale. It was considered for use in the intermediate-scale methane synthesis experiments, only because its effectiveness would allow the investigation to continue. A difficulty arose, however, when it was found that the absorption of hydrogen sulphide from the gas after it had passed for the second and third times over the copper-chromium catalyst (*i.e.*, when only traces of hydrogen sulphide were present), was not efficient unless the gas were first cooled to atmospheric temperature.

As a result of laboratory investigations both at Leeds and at Poole, two methods now appear to be practicable for the removal of the final traces of organic sulphur.

It was first established that small concentrations of hydrogen sulphide could be absorbed by nickel hydroxide at 150° to 200° C. It was then found that, after sulphiding, this same reagent was superior to copper-chromium as a conversion catalyst for organic sulphur, and that a filling of part sulphided and part unsulphided material could, therefore, be used to remove the final traces of organic sulphur. Secondly, it was found that unsulphided nickel hydroxide would absorb organic sulphur without the preliminary passage through sulphided material, although conclusive data are not yet available to show whether the effectiveness of the system is reduced by the omission. One of these systems will be used in the intermediate-scale apparatus for the removal of the final traces of organic sulphur.

In the meantime, work has continued on the conditions of the preparation and operation of the copper-chromium catalyst for the first and main conversion stage, although present indications are that sulphided nickel hydroxide will be superior for this purpose also.

(a) The Conditions of Operation of the Copper-Chromium Catalyst

An early question to be settled was whether to support the copper-chromium catalyst on active carbon or on alumina, most of the previous work having been done with active carbon, but alumina having certain advantages. Table 1 shows that active carbon provides

* From the 7th Annual Report of the Gas Research Board. (G.R.B. Publication 24.)

a more active catalyst at the high space velocity required, while Table 2 indicates 270° C. as its optimum temperature of use, although the variation in performance over the range 250° to 300° C. is not great.

TABLE 1.—*The Activity of Copper-chromium Catalysts supported on Active Carbon and on Alumina*

Organic sulphur in inlet gas : 15 to 30 gr. per 100 cu.ft.
Temperature : 290° C.

Space velocity (vol. per vol. per hr.)	Organic sulphur in outlet gas (gr. per 100 cu.ft.) Active carbon support	Alumina support
500	0.35	0.32
1,000	0.16	0.18
2,000	0.21	0.20
4,000	0.28	0.70
7,000	0.50	3.0
8,500	—	8.0
10,000	0.45	—

TABLE 2.—*The Influence of Temperature on the Activity of a Copper-chromium Catalyst*

Organic sulphur in inlet gas : 15 to 17 gr. per 100 cu.ft.
Space velocity (vol. per vol. per hr.) : 5,000

Temperature (°C.)	Organic sulphur in outlet gas (gr. per 100 cu.ft.)
250	0.22
260	0.20
270	0.19
280	0.24
290	0.22
300	0.22
320	0.23
350	0.39

TABLE 3.—*The Influence of the Addition of Steam on the Conversion of Organic Sulphur Compounds by means of a Copper-chromium Catalyst*

Organic sulphur in inlet gas : 15 to 16 gr. per 100 cu.ft.
Temperature : 270° C.
Space velocity (vol. per vol. per hr.) : 5,000

Steam added (vol. per 100 vol. dry gas)	Organic sulphur in outlet gas (gr. per 100 cu.ft.)
7.5	0.20
11.1	0.18
25.0	0.11

The degree of conversion obtained over the copper-chromium catalyst determines the consumption of the final special absorbent. Because of this, some experiments were made to determine how far the conversion could be improved by adding steam to the gas, steam affecting the position of equilibrium established through a hydrolysis reaction. Table 3 shows that, although this effect was achieved the amounts of steam required to produce it are uneconomic.

(b) The Absorption of Hydrogen Sulphide by Iron Oxide

It was the original intention to use existing oxide boxes at Poole to absorb the hydrogen sulphide produced over the first stage of the copper-chromium catalyst. This involved operating the boxes at an abnormally low space velocity (1.5 to 2.5), and it was then found that the organic sulphur in the gas increased in passing through them, in spite of the oxide filling having been sprayed with copper sulphate solution. Investigation of this observation showed that, although it was exaggerated by the low space velocity, it was also a property of the particular oxide in use; with a different oxide, the increase was negligible.

Table 4 gives the results obtained, in view of which it was decided to use new, small boxes to employ a more suitable oxide at a more appropriate rate of flow of gas. This has been done with satisfactory results.

TABLE 4.—*The Effect of Iron Oxides on the Organic Sulphur Content of Synthesis Gas*

Oxide	Space velocity (vol. per vol. per hr.)	Organic sulphur entering oxide (gr. per 100 cu.ft. of gas=A)	Organic sulphur leaving oxide (gr. per 100 cu.ft. of gas=B)	Difference =B—A
X	26.5	0.20	0.20	Nil
X	10.5	0.19	0.31	0.12
X	4.7	0.19	0.42	0.23
X	2.5	0.17	0.58	0.41
X	1.7	0.14	0.81	0.67
X	0.3	0.26	2.40	2.14
X+1% Na_2CO_3	26.5	0.21	0.24	0.03
X+1% Na_2CO_3	2.5	0.26	0.69	0.43
Y	26.5	0.24	0.23	—0.01
Y	2.5	0.19	0.18	—0.01
Y	1.7	0.20	0.23	0.03
Y	0.3	0.26	0.23	—0.03
Y, fouled with crude B.W.G. and then aerated	26.5	0.13	0.17	0.04
	1.7	0.17	0.30	0.13
	0.3	0.15	0.90	0.75

(c) The Absorption of Traces of Hydrogen Sulphide by Precipitated Nickel Hydroxide

Two necessary properties of a reagent for the removal of hydrogen sulphide are that it should absorb completely traces of hydrogen sulphide, and that it should have a reasonably long life. The reagents examined during 1944-45, although effective enough, failed to meet the latter requirement, the best absorbing only 3.5% of its weight of sulphur before failing. During the past year, more success has been achieved with nickel hydroxide, precipitated without carrier or binder and containing 1 to 2% of sulphur as sulphate to inhibit the synthesis of methane. The data in Table 5 show that the plain hydroxide is effective at a temperature (150° C.) below the threshold temperature for methane synthesis, until it has absorbed 9.9% of its weight of sulphur. The addition of 1% of sulphur to the reagent allows the temperature to be raised to 200° C., but then only 7.5% of sulphur is absorbed. Greater addition of sulphur to the catalyst reduces its its effectiveness still further.

TABLE 5.—*Absorption of Hydrogen Sulphide from Water Gas by Nickel Hydroxide*

Sulphur content of water gas : 1 gr. as H_2S per 100 cu.ft.
Space velocity : 2,500 vol. per vol. per hr.

Reagent	Temperature (°C.)	Sulphur absorbed before the appearance of 0.001 gr. per 100 cu.ft. in exit gas: Per cent. of weight of material	Per cent. of that needed to sulphide the metal completely
Nickel hydroxide + 2% of sulphur as sulphate	200	1.8	5.5
	250	0.1	0.4
Nickel hydroxide + 1% of sulphur as sulphate	200	7.5	23.4
	250	1.3	4.0
Nickel hydroxide	150	9.9	30.9

(d) The Conversion of Organic Sulphur Compounds by Sulphided Nickel Hydroxide

Further experiments at Leeds with plain nickel hydroxide have shown that, after it has been sulphided during the removal of hydrogen sulphide, it is effective for the conversion of the organic sulphur compounds present in water gas at as low a temperature as 150° C. It was found, moreover, that if the sulphided material is followed by unsulphided nickel hydroxide at the same temperature, the total sulphur in the outlet gas is only 0.001 gr. per 100 cu.ft.

The results of an experiment along these lines are given in Table 6.

TABLE 6.—*Final Purification of Water Gas by Nickel Sulphide and Nickel Hydroxide*

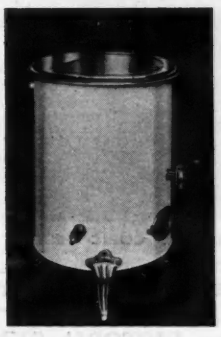
Temperature : 150° C.
Space velocity : 1,250 vol. per vol. per hr.

Time after start (hr.)	Organic sulphur in inlet gas (gr. per 100 cu.ft.)	Sulphur in outlet gas (gr. per 100 cu.ft.) After nickel sulphide: Organic sulphur	H_2S	After nickel hydroxide: Total sulphur
300	1.00	0.05	0.95	0.001
400	0.99	0.03	0.96	0.001
600	1.33	0.01	1.32	0.001

(To be continued.)

A New Wash Boiler

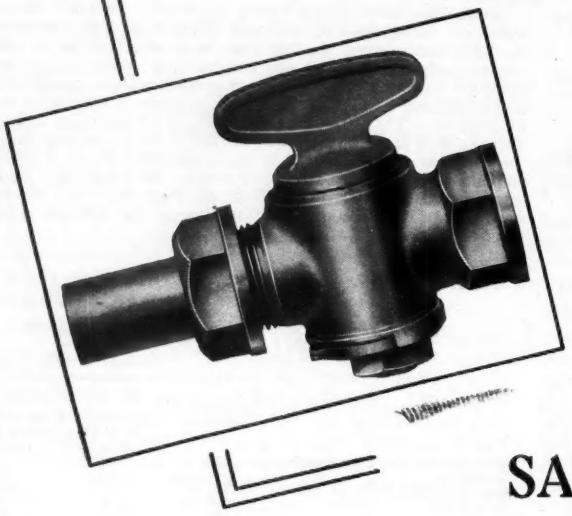
A high class gas wash boiler as illustrated here is now being produced by Richard Haighton, Ltd., Vulcan Iron Works, Nelson. Capacities range from eight to 10 gall. and the circular body is of galvanized steel, specially treated with cream synthetic heat resisting enamel. There is a highly polished cast aluminium top ring, and the lid is of polished copper or polished aluminium.



The feet are in cast aluminium and the lighter hole frame is of polished cast aluminium. The cast iron burner is of the ring type, with a brass adaptor for hose union or quarter-inch gas supply. The circular pan is of 8 lb. tinned copper, the protector baffle of sheet steel, and the easy-clean draw-off tap is chromium plated.

An alternative model has a ground top finished matt, and a galvanized body.

BRASSWORK



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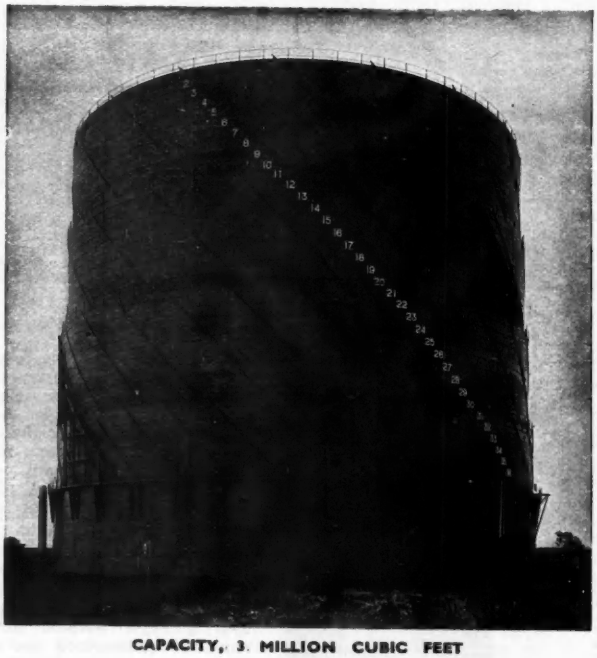

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Town Gas in the Ceramic Industry*

By J. E. STANIER, G.M., M.I.Chem.E.
(Chief Engineer and General Manager, Stoke-on-Trent Gas Department)

CONSIDERABLE advances have been made in the application of town gas to the various heating processes of the ceramic industry during the last thirteen years. During the war years, following the restrictions in production from this industry, the rate of progress was interrupted, but a rapid return to normal conditions was noticeable during the latter part of 1945 and early in 1946, when the total requirements of the ceramic industry exceeded the pre-war figure.

The rate at which new gas-fired kilns are coming into operation, together with a small number of tunnel ovens previously closed down during 1939, can be judged from the returns of the Stoke-on-Trent Gas Department which indicate that for the various heat requirements of the pottery and allied industries, the consumption of gas for the June quarter of 1946 was 50% greater than the pre-war demand. The results are sufficient indication of the progress being made in the change-over from solid fuel to gaseous firing in the ceramic industry.

The ceramic engineer, when contemplating the introduction of a tunnel kiln, considers the following aspects :

(1) Economies in fuel;
(2) Production of better ware;
(3) Better control of the firing process;
(4) Reduced labour costs;
(5) Better working conditions for the attendants;
(6) Reduced expenditure on saggars;
(7) Smoke abatement.

Economies in Fuel

The following tabulation gives the heat requirements per ton of ware for the periodic kiln using solid fuel and the comparative figures for town gas in a continuous tunnel kiln, together with the actual weight of fuel necessary if consumed direct at the factory or carbonized at the gas-works for the production of an equivalent amount of gas to fire the same weight of ware.

Class of ware	Therms per ton of ware: Using solid fuel in periodic kiln	Therms per ton of ware: Using town gas in continuous tunnel kiln	Tons of coal required: Per ton of ware in the periodic kiln	Tons of coal required: For production of gas/ton of ware in a continuous tunnel
Biscuit tiles	215	83	0.74	1.00
Glost tiles	436	50	1.50	0.60
Sanitary biscuit	519	163	1.76	1.95
General earthenware, biscuit, saggared	262	120	0.90	1.44
Ditto, open placed	—	94	—	1.14
General earthenware, glost	355	78	1.22	0.94
Sanitary fireclay	847	120	2.91	1.44
Electric porcelain	372	115	1.27	1.39

A study of these results shows that the thermal requirements for firing the above different classes of ware are on an average in the ratio of one therm of gas being the equivalent of four therms of coal. In the case of glost tile firing, this ratio is increased to 1 : 8½, whilst the firing of general earthenware (biscuit) in saggars only gives a proportion of 1 : 2.

In comparing the tonnage of coal required at the factory for periodic kilns as against the fuel necessary at the gas-works for the production of gas to equal the same tonnage of ware fired by gas tunnel kilns, the following residuals have to be taken into account for each ton of coal carbonized, which would be lost if solid fuel had been used in a periodic kiln:

8.5 cwt. of saleable coke	=	119 therms
1.0 cwt. of saleable breeze	=	11 „
15 gall. of tar	=	26.5 „
3 gall. of benzole	=	4.4 „
		160.9

Assuming that 83 therms of gas are yielded per ton of coal carbonized, nearly double this amount of heat energy is contained in the residuals, either in the form of coke or liquid hydrocarbons.

Taken as an average, a ton of coal utilized at the gas-works is equivalent to supplying the necessary amount of town gas for firing the same quantity of ware as nearly 1.2 tons of coal if used in the raw state in the periodic kiln.

From a coal conservation aspect, town gas firing of continuous tunnel kilns (if consideration is given to the balance of thermal value of the residual products of carbonization) is equivalent to a saving for the nation of more than two-thirds of the heat energy of every ton of coal now used in periodic kilns.

Although these comparisons show a vast improvement in fuel saving, there are still considerable reasons for further investigation and improvement. For example, the modern muffle oven operated on general glost earthenware will have a gross efficiency of about 60%, which is of a high order. On the other hand, the weight of ware fired compared to truck furniture will only be in the proportion of three parts of ware by weight to ten parts of furniture, bringing the net efficiency down to a figure nearer 15%.

While some improvement has been made recently in this respect from the figures already quoted, it is quite apparent that further investigations should be undertaken to effect improvements in the kiln furniture with a view to reducing the proportion mentioned above, thereby increasing the efficiency figures, although it will be appreciated that the kiln superstructure must be sound and at the same time have a very low maintenance.

Another factor of importance is that the length and cross section of the kiln should be so arranged that the ware can be fired on the minimum cycle commensurate with getting first class ware, the maximum output obtainable, and a low maintenance on trucks and truck furniture. Or, expressed in other terms, it will be found that a kiln with a relatively small, well-loaded truck firing on the optimum cycle will be more efficient than a kiln of the same length firing the same output but built with a larger truck and firing on a slower cycle.

This can be well explained when one considers the principle on which a tunnel kiln operates. The goods are fired in counter current to the combustion air or gases, so that the speedier service and smaller section allows the cooling goods to give up their heat more readily to the incoming combustion air, and for the outgoing waste gases to transfer their heat for preheating the incoming goods.

Vigorous Experimental Work

Experimental work in connexion with direct firing, without either muffles or saggars, is being pursued with vigour by the ceramic research engineer, with the object of still further uplifting the thermal efficiency, and in some cases it has proved successful but whether or not its application universally throughout the many grades of pottery and tiles is imminent is difficult to say.

New types of burners such as radiant cups, and radiant blocks, seem to offer some possibilities in this direction, particularly so from the fact that combustion is completed within the burner head totally eliminating any flames from the interior of the tunnel, and it is claimed that it is possible to fire all classes of ware without protective saggars, thus greatly reducing the ratio of weight of gross load to weight of pay load. An additional claim with this type of burner is that they can be raised to maximum temperature in a short time, enabling the tunnel to be brought into production after shut downs much quicker than when using the conventional type of burner. However, as pottery users normally only close down their oven once a year at most at Wakes Week, this is not very important, and it must be mentioned that this type has a disadvantage in so much as it uses all cold air, thereby losing some efficiency. In addition, the burner equipment is very expensive in first costs.

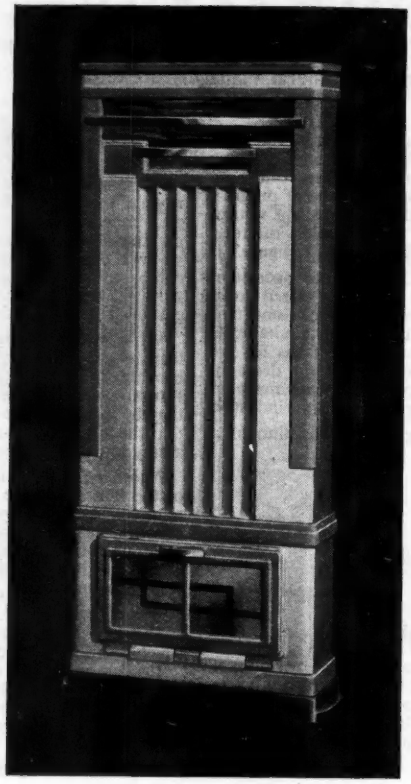
Another factor in connexion with gas fired continuous tunnel ovens which is of great importance, and which will still further increase the relative efficiency compared with the periodic kiln, is the fuller utilization of waste heat. This should bring many operating advantages throughout the factory, *e.g.* heat for space warming in addition to the normal drying operations can be secured from the tunnel kiln products of combustion, the cooling zones and radiation from the kiln structure.

In some cases waste heat recovery from a tunnel oven might partially eliminate the need for a steam raising plant, thus saving huge quantities of fuel. It will be realized, therefore, that scope still exists for further fuel economies with gas-fired tunnel ovens in the future.

Better Ware and Better Control of Firing

One important contribution which gas-fired tunnels make towards better ware is that the success of firing is no longer dependent upon the human element. Not only is control greatly simplified, and made entirely automatic if required, but the kiln may be set to any desired firing curve with the assurance that the curve will be constantly adhered to and remain constantly uniform. Temperature variation through the height or width of a setting do not fluctuate as in periodic kilns. Ware is subjected to steady increases and decreases in temperature, as

* Paper presented to the Ministry of Fuel and Power "Fuel and the Future" Conference, Oct. 8.



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against the rapid changes which may occur even in the most carefully fired periodic kiln. As a result the loss through spoilage in firing becomes negligible.

The absence of solid fuel and the concomitant smoke dust, ashes and dirt, removes the dangers of dirty and spotted ware which has always proved a serious problem to the ceramic industry and has contributed towards a large proportion of spoiled ware.

Reduced Labour Costs

Town gas requires no storage space on the works, and leads to a considerable saving in labour charges and other expenses incidental to solid fuel, such as cartage of fuel and removal of ashes. The heavy manual labour attached to firing periodic solid fuel kilns and the constant attention to fires and dampers is removed entirely. Control of gas-fired ovens can be carried out automatically by reliable instruments, and supervision is reduced to a minimum. Alterations to temperatures or firing schedules are reduced to the regulation of a few valves, and the operator is in the position of knowing that uniform results may be reproduced at any time.

Economies in labour are most marked as regards placing, since the regular output of a tunnel kiln can be dealt with by between one-third and one-half the number of men required to place and draw the saggars in a periodic kiln, while the conditions for the workers are infinitely better in every respect. Taking into consideration the fact that the placers with tunnel kilns are in regular employ, as compared with the need for placing teams only when placing and drawing the periodic kilns, the former represents a direct saving of labour of from 25% to 35%.

Better Working Conditions

Working conditions in the ceramic industry have improved tremendously following the adoption of town gas for firing and process work. Mention has already been made of the reduction in carrying and lifting ware when placing for firing and the absence of dust, dirt and ashes.

The factory is no longer blanketted in smoke following each " baiting " of the periodic kilns, nor are employees required to enter kilns, which are at uncomfortably high temperatures, to draw the ware. Temperature conditions throughout the factory are improved and equalized. Heating of shops, drying plant, &c., can be effected without discomfort to the employees.

Yards and approaches can be kept clear of accumulations of ashes or dumps of solid fuel, and give the management an opportunity to set an example in cleanliness and more hygienic conditions which are quickly appreciated by the workers.

Reduced Expenditure on Saggars

Opinion seems to be divided on the merits and efficiencies of open fired and muffle type tunnels, although of late most of the larger firms are building their biscuit kilns open fired and their glost kilns muffled. There is no doubt that the open fired type would be more efficient for glost firing were it generally practicable to eliminate saggars and place the ware open on the trucks. Town gas as at present distributed is sufficiently low in organic sulphur to have no detrimental effect on many classes of ware, and therefore saggars are not always essential with this type of firing.

Whereas in periodic solid fuel kilns the saggar has to act as protector of the ware, as well as support to the other saggars in the bung, in the case of tunnel kilns the weight of bungs is greatly reduced, with the result that much lighter saggars can be used. By this means it has been possible to reduce the ratio of saggars to ware from 10: 1 to 3: 1 with corresponding savings in fuel consumption. Breakages of saggars for the same reason are much lower, and consequently expenditure is correspondingly reduced.

While saggars do afford some definite advantages as regards placing there is no doubt that equal advantages could be derived from correctly designed kiln furniture, provided suitable refractories were available. This is a matter which is having close attention at the moment, and the problem, when solved, will have a material effect in reducing full consumption and increasing efficiency in firing.

Smoke Abatement

Out of the approximate tonnage of 1,175,000 tons of coal used for industrial purposes in the North Staffordshire district, it is estimated that some 750,000 tons are used by the ceramic industry and by the brick and roofing tile trades. The majority of this tonnage will be used for firing processes, with smaller quantities being consumed for ancillary purposes, such as steam raising, clay drying, &c.

Based on the Gas Department's thermal yields, to produce town gas used for ceramic firing (excluding the brick and roofing tile trades) on the present demands of the industry, some 125,000 tons of coal is required, from which, in addition to the gas, some 375,000 gall. of crude benzole, 1,875,000 gall. of tar and 60,000 tons of coke and breeze were produced. Using the figures quoted above, it will be seen that some 20% of the pottery and allied firms have changed over from raw coal to town gas firing, so that there remains a great deal of scope for the future before smoke is completely eliminated.

As mentioned, the carbonization of coal affords additional benefits in that coke and by-products result, and it represents the peak of present technical achievement. This is very well illustrated simply by stating that, of every 100 tons of coal which enters a gas-works, at least 80 tons of the heat energy of the fuel is obtained in one form or another, by way of heat units in gas, coke, benzole, tar, &c.

Should it transpire that coke becomes universally accepted as a basic smokeless fuel, it is not beyong the realms of possibility that the demand would exceed the ability of the country's gas-works to supply it, and the production of this coke might be carried out at the pithead. If such a project should materialize, and since the North Staffordshire district possesses a large number of colleries, surplus coke oven gas would be available in fairly large quantities. Having in mind the potential industrial requirements of our staple trade, most of this surplus gas could be distributed and applied locally with very beneficial results, and would accelerate the trend toward domestic and industrial smoke abolition.

Drying

The heat requirements of the ceramic industry are by no means limited to the firing of ware, a considerable volume being used for process work, of which drying is the most important. Until recent years, practically all this drying has been carried out by steam—either live or exhaust—in rooms or chambers specially set apart for the work. Few, if any, manufacturers have accurate costs of this process, partly due to the wide variations in moisture content of the clay at different stages of " making " and to the lack of instruments for measuring the heat supplied to the drying plant.

The raw clay taken from the filter press has a moisture content mainly in the form of added water, of 20% or more. This must be reduced in some cases to, approximately, 6%, in other cases to 1%, according to the ware being produced. Further problems arise due to the absorbent properties of the clay when in a relatively dry condition and the fact that at the " dipping " stage moisture is absorbed from the liquid glaze.

Gas has not only been successfully adopted for heating existing drying chambers, but also as the heating medium for new drying plant, including conveyor and rotating chamber types in which the process is more or less continuous, and has considerably reduced the cost of operation and the time required for drying. In the case of cups, saucers, plates, &c., produced in or on moulds, further economies have been effected in the longer life of moulds and the reduced number required due to the shortened period of drying.

As figures of costs with solid fuel are not available it has not been possible to work out comparative costs for gas, but the following details give an indication of the results obtained in various types of gas-heated drying plant.

	Weight of clay	Initial moisture	Final moisture	Gas/ton dried cu.ft.
Drying clay from filter press, chamber type dryer with bar burners below stillage ...	9 tons	20%	4%	1,400
Ditto, chamber type dryer with radiant tube burners in stillage...	11 tons	20%	4%	1,200
	Cups dried per 8 hr. day doz.	Gas consumption per day cu.ft.	Gas consumption per dozen cups cu.ft.	
*Drying cups in moulds in semi-continuous dryer with gas-heated air circulator	275	1,300	4.72	
*Drying dipped cups in continuous radiant-heat dryer, gas heated	240	1,600	6.6	

* It is claimed that by these two methods of drying the time required for making and drying is reduced from two days to one hour.

Frit Melting

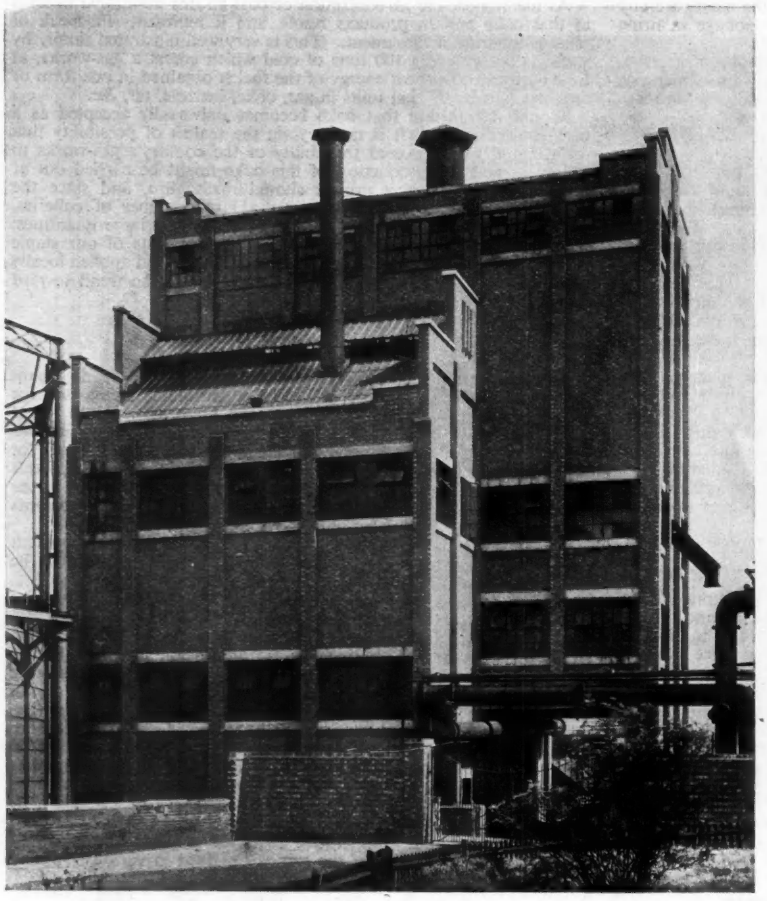
Town gas is being used in both rotary and batch type melters for the production of the frits required for glazes and enamels used in the ceramic and vitreous enamelling industries. It has been our experience that melting costs in the rotary type melters are higher than the batch type, although the former cost less for maintenance and, generally speaking, can be brought into effective operation in shorter time.

Gas consumption per pound of frit " off " varies considerably according to the type of frit and the condition of the melting furnace. With the smaller rotary types up to a length of 5 ft., the consumption for a good quality frit averages approximately 12 cu.ft. per pound of frit " off." The batch type melters are usually about 10 ft. to 12 ft. in length and 2 ft. 3 in. to 3 ft. 3 in. wide, single burners being employed in the narrower ones and two burners in those with a width above 2 ft. 6 in. Figures as low as 8.43 cu.ft. of gas per pound of frit " off " have been recorded for good quality frits in newly-built furnaces, rising to 10 to 11 cu.ft. per pound as the interior brickwork deteriorates.

The following comparison of fuel consumptions on coal-fired and gas-fired melters of identical capacity show the economy of gas in this connexion.

	Coal-fired frit kiln	Gas-fired frit kiln
Weight of charge " on "	9 cwt.	9 cwt.
Melting time	2.5 hrs.	2.5 hrs.
Therms per melt	72.8	43.9

This is equivalent to a reduction in fuel consumption of 41%.



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Creosote for timber preservation is 5½d. per gall. ex sellers' works in bulk in minimum 800 gall. lots.

Cresylic Acid prices range from 3s. 6d. to 5s. per gall. ex makers' works according to grade.

Coal Tar Naphtha prices range from 1s. 11d. to 2s. 11d. per gall. and *Xylol* prices from 3s. 3½d. to 3s. 6d. per gall., carriage paid buyers' address in bulk in 1,000 gall. lots.

The demand for all products continues very heavy.

There is also considerable enquiry for export, but the heavy home demand leaves little material available for shipment.

The Provinces

December 17.

Average prices of gas-works products: Pitch, 75s. per ton; toluole, naked, North, 90's, 2s. 4d. to 2s. 6⅝d. per gallon; pure, 3s. 2⅛d. Prices for carbolic acid 60's, anthracene, creosote oil (hydrogenation), coal tar oils (timber preservation, &c.), and strained anthracene oil are controlled by Government Orders. Prices for road tar were increased by a half-penny per gallon by S. R. & O. 1945, 229, under which Order there was also an increase of 5s. per ton in the price for standard creosote-pitch mixture.

Scotland

December 14.

Deliveries are proceeding regularly with home prices unchanged.

*Refined Tar.** Yield to the Distiller is 5d. per gall. ex works, naked. *Creosote Oil.* Timber preserving quality,* 5½d. to 6½d. per gall.; Hydrogenation Oil,* 5⅞d. per gall.; Low Gravity or Virgin Oil,† 7⅛d. to 7½d. per gall. ; Benzol Absorbing Oil, 6½d. to 8d. per gall. *Refined Cresylic Acid** is 3s. 6d. to 4s. 6d. per gall. ex works, naked, according to quality. *Crude Naphtha,*† 7d. to 8d. per gall. *Solvent Naphtha.** Basic maximum prices delivered in bulk, 90/160 grade, 2s. 10d. per gall. and 90/190 Heavy Naphtha, Unrectified, 2s. 0½d. per gall.; Rectified, 2s. 4d. per gall. *Pyridine,*† 90/160 grade, 15s. per gall., and 90/140 grade. 17s. per gall.

* Price controlled. † Uncontrolled.

Stocks and Shares

The demand for gas stocks and shares continued again last week and with stock in short supply a number of prices were marked up still further. Fixed-interest stocks, especially the 5% debenture issues, were the chief features and enquiries for these will generally meet with the response that there are no sellers, only buyers. The proprietors of the Oriental Gas Company have now received details of the offer to purchase the undertaking, the price being £275 per £100 stock.

The following were the price changes last week:

OFFICIAL LIST

Bombay		48/	— 50/	+ 6d.
Bournemouth max. div.		160	—165	+ 2
Do. 4 p.c. deb. ...	xd	112	—117	Dec. 11
British ord.		127	—132	+ 1
Do. 5½ p.c. "B" cum. pref.		110	—115	+ 1
Do. 4 p.c. red. deb....	xd	97	—102	Dec. 11
Commercial ord.		84	— 87	+ 3½
Do. 3 p.c. deb. ...	xd	93	— 98	Dec. 11
Do. 5 p.c. deb.		123	—128	+ 6
Croydon 5 p.c. deb.		130	—135	+ 3
East Surrey 5 p.c. deb.		130	—135	+ 3
Gas Light 3½ p.c. max.		95	—100	+ 1½
Do. 5 p.c. red. deb. ...		106	—109	+ 1
Mid Southern Utility 4 p.c. pref. ...		105	—110	+ 2
Plymouth & Stonehouse ord.	xd	110	—115	Dec. 11
South Metropolitan ord.		94½	— 97½	— ½
Do. 4 p.c. pref.		105	—110	+ 4½
South Suburban 5 p.c. deb.	xd	130	—135	Dec. 11
Tottenham 4 p.c. deb. ...	xd	111	—116	Dec. 11
United Kingdom 4½ p.c. 2nd non. cum. pref.	xd	20/	— 22/	Dec. 11
Wandsworth 4 p.c. pref.		105	—110	+ 1½
Do. 5 p.c. deb.	xd	130	—135	Dec. 11
Do. 4 p.c. deb. ...	xd	110	—115	Dec. 11

SUPPLEMENTARY LIST

Brighton 5 p.c. deb.... ...	xd	130	—135	Dec. 11
Cheltenham 4 p.c. deb. ...	xd	110	—115	Dec. 11
Croydon 4 p.c. pref.		105	—110	+ 2
Do. 4 p.c. deb. ...		110	—115	+ 5
East Surrey 6 p.c. cum. pref. ...		127	—132	+ 2
Newport (Mon). 5 p.c. deb.	xd	125	—130	Dec. 11
Plymouth & Stonehouse 5 p.c. deb.		128	—133	+ 3
Reading 4 p.c. deb.	xd	112	—117	Dec. 11
Romford 4 p.c. deb....		105	—110	+ 2
Uxbridge 5 p.c. deb ...	xd	130	—135	+ 3

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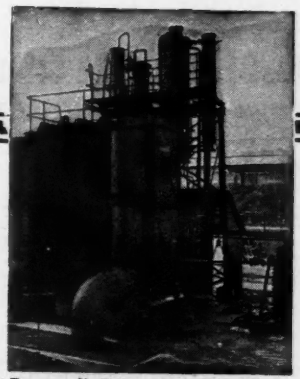

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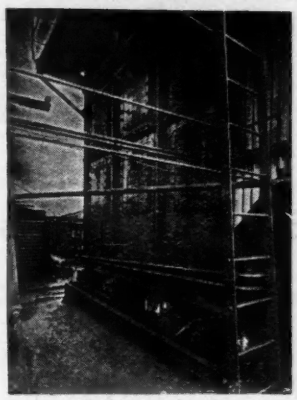

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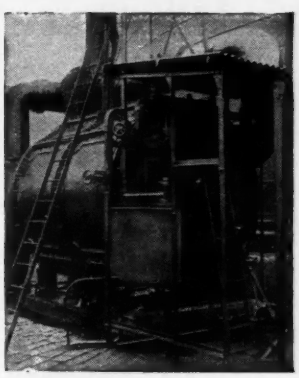

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